IMP. INST. ENTOM.
— LIBRARY —
No. 6354

J.L.W.

Digitized by the Internet Archive
in 2025

https://archive.org/details/ecological-entomology_1933_81

TRANSACTIONS

OF THE

ROYAL ENTOMOLOGICAL SOCIETY

OF

LONDON

9

THE

TRANSACTIONS

OF THE

ROYAL ENTOMOLOGICAL SOCIETY

OF

LONDON

VOL. LXXXI

LONDON
PUBLISHED BY THE SOCIETY AND SOLD AT ITS ROOMS
41 QUEEN'S GATE, S.W. 7

1933

DATES OF PUBLICATION OF PARTS

Part I (pp. 1–132) . . . . . Published 30th June, 1933

Part II (pp. 133–234). . . . . Published 30th December, 1933

THE ROYAL ENTOMOLOGICAL SOCIETY OF LONDON.

FOUNDED, 1833.

INCORPORATED BY ROYAL CHARTER, 1885.

PATRON: HIS MAJESTY THE KING.

OFFICERS and COUNCIL for the SESSION 1933-1934.

President and Honorary Life President.

PROF. E. B. POULTON, M.A., D.Sc., F.R.S.

Vice-Presidents.

H. ELTRINGHAM, M.A., D.Sc., F.R.S.
K. JORDAN, PH.D., F.R.S.
R. W. LLOYD.

Treasurer.

A. F. HEMMING, C.B.E., F.Z.S.

Secretary.

S. A. NEAVE, O.B.E., M.A., D.Sc., F.Z.S.

Registrar.

F. J. GRIFFIN, A.L.A.

Other Members of Council.

PROF. W. A. F. BALFOUR-BROWNE, F.R.S.E., F.L.S.
SIR T. HUDSON BEARE, B.Sc., F.R.S.E.
K. G. BLAIR, D.Sc.
H. ST. J. K. DONISTHORPE, F.Z.S.
BRIGADIER W. H. EVANS, C.S.I., C.I.E., D.S.O.
MAJ. R. W. G. HINGSTON, M.C.
MISS C. LONGFIELD, F.Z.S.
SIR GUY A. K. MARSHALL, C.M.G., D.Sc., F.R.S.
O. W. RICHARDS, M.A.
N. D. RILEY, F.Z.S.
V. B. WIGGLESWORTH, M.A., B.CH., M.D.

Trustees of the Society.

R. W. LLOYD.
PROF. E. B. POULTON.
THE RT. HON. LORD ROTHSCHILD.

Finance and House Committee.

R. W. LLOYD (*Chairman*).
R. ADKIN.
SIR T. HUDSON BEARE, B.Sc., F.R.S.E.
H. WILLOUGHBY ELLIS, F.Z.S.
BRIGADIER W. H. EVANS, C.S.I., C.I.E., D.S.O.
K. JORDAN, PH.D., F.R.S.
O. W. RICHARDS, M.A.

Publication Committee.

N. D. RILEY, F.Z.S. (*Chairman*).
H. ST. J. K. DONISTHORPE, F.Z.S.
H. ELTRINGHAM, M.A., D.Sc., F.R.S.
T. BAINBRIGGE FLETCHER, R.N., F.L.S.
SIR GUY A. K. MARSHALL, C.M.G., D.Sc., F.R.S.
M. E. MOSELY.
B. P. UVAROV.

Library Committee.

K. JORDAN, PH.D., F.R.S. (*Chairman*).
PROF. P. A. BUXTON, M.A.
L. G. HIGGINS, M.A., F.R.C.S.
A. D. IMMS, M.A., Sc.D., F.R.S.
R. W. LLOYD.
H. J. TURNER.
H. WILLOUGHBY ELLIS, F.Z.S.

Committee for the Protection of British Insects.

THE RT. HON. LORD ROTHSCHILD, D.Sc., F.R.S. (*Chairman*).
R. ADKIN.
CAPT. E. BAGWELL-PUREFOY, F.Z.S.
W. J. DOW.
J. C. F. FRYER, O.B.E., M.A.
COL. F. A. LABOUCHERE.
N. D. RILEY, F.Z.S.
W. G. SHELDON, F.Z.S.
H. M. EDELSTEN (*Secretary*).

The Executive Officers of the Council are *ex-officio* members of all Committees.

CONTENTS

PAGE

ANDREWES (H. E.). On the types of Oriental Carabidae described by V. de Motchulsky. Part II 1

CARPENTER (G. D. HALE, M.B.E., D.M.). Attacks of birds on butterflies 21

COCKAYNE (E. A., D.M., F.R.C.P.) and HAWKINS (C. N.). Two-horned Sphingid larvae (a recessive mutation) 27

DESHPANDE (V. G., M.Ag., Ph.D.). On the anatomy of some British Aleurodidae 117

ELTRINGHAM (H., M.A., D.Sc., F.R.S.). On the tarsal sense-organs of Lepidoptera 33

GIBBINS (E. G.). Studies on Ethiopian Simuliidae. *Simulium damnosum*, Theo. 37

HAWKINS (C. N.). Abnormal larvae of *Amathes* (*Orthosia*) *macilenta*, Hb. (Lep.) 223

HINCKS (W. D., M.P.S.). The Passalidae of the Belgian Congo ... 53

JACKSON (C. H. N., Ph.D., M.Sc.). On an advance of Tsetse-fly in Central Tanganyika 205

LYLE (G. T.). A Catalogue of the British Braconidae 67

MANSBRIDGE (G. H., M.A., D.I.C.). On the biology of some Ceroplatinae and Macrocerinae (Diptera, Mycetophilidae) 75

MORLEY (Claude, F.Z.S., F.G.S.) and RAIT-SMITH (W., F.Z.S.). The Hymenopterous parasites of the British Lepidoptera 133

PAGDEN (H. T., M.A.). Two new Malayan Sphecoids 93

SHARGA (U. S., M.Sc., Ph.D.). On the internal anatomy of some Thysanoptera 185

WILLIAMS (C. B., Sc.D.). Further collected records relating to Insect Migration 103

INDEX 231

TRANSACTIONS

OF THE

ROYAL

ENTOMOLOGICAL SOCIETY

OF LONDON

VOL. 81. 1933.

ON THE TYPES OF ORIENTAL CARABIDAE DESCRIBED BY V. DE MOTCHULSKY

(PART II)

By H. E. ANDREWES.

[Read 7th December, 1932.]

A FIRST paper on Motchulsky's types appeared in these Transactions in 1928 (pp. 1–24); this dealt with about seventy species from South-East Asia, and included most of the obscure and doubtful ones. There remained, however, a further forty-six species, including some from China and Japan, which I desired to see and identify, and of which the types were known to be in the University Museum at Moscow. Thanks to the courtesy of Mr. Boris Kuzin, to whom I offer my sincere thanks, I have now been enabled to examine these, and in the following pages will be found some notes on them, together with redescriptions where necessary; I am not here repeating the explanations given in the introduction to my former paper, of which this is only a second instalment. I have devoted more space to the genus *Amblystomus* than to any other, because Motchulsky described seven species, all very inadequately, which have frequently been misidentified by later authors, especially by H. W. Bates; I should like to have dealt with this genus even more fully, but time is wanting, and I must leave this for the future.

For their assistance in lending me the various specimens of *Amblystomus* referred to by other authors, I have to thank Dr. Gestro of the Genoa Museum, Mr. Ball of the Brussels Museum, Mr. Lesne of the Paris Museum, and Mr. Fleutiaux. Dr. Jan Obenberger of the Prague Museum has also been kind enough to send me the long series of specimens taken by Helfer in Burma.

The thirty-five lost types referred to in my former paper have not meanwhile been found, and there seems now to be little hope of tracing them.

The species have been grouped as before, the numbers following the references to the Moscow Bulletin referring to the parts, not the volumes. As my "Catalogue of Indian CARABIDAE," with full references, has now appeared, I

am only inserting here such as seem essential for the purposes of this paper, principally those dealing with species not included in the catalogue.

(i) *Bull. Mosc.* **1861,** i : 98–108.

1. **Tetragonoderus notaphioides** (p. 99).

Three examples, two on one card bearing a label " I. or. Ceyl. Colomb." in addition to the name, and a separate " type " label; the third example is labelled " Ind. or." Chaudoir did not know the species, but Bates identified it correctly among the Coleoptera collected by the late George Lewis in Ceylon.

The species occurs in Central and Southern India and Ceylon, its habitat extending up the East Coast as far as Orissa. It may be of interest to note that Mr. E. A. d'Abreu found a specimen in the Bhandara district, Central Provinces, on the nesting site of a bee-eater, *Merops philippinus*, L., and the late Dr. N. Annandale took one on Barkuda Island, Lake Chilka, from the nest of an ant, *Pheidole rhombinoda*, Meyr.

2. **Pachytrachelus (Batascelis) ceylonicus** (p. 103) = *P. oblongus*, Dej.,* 1831, Spec. Gen. **5 :** 813.

One specimen only, bearing a " type " label, and a second label inscribed " *Batoscelis ceylonicus* Motch. I. or. Ceyl. Nura. El." (= Nuwara Eliya); this, as anticipated, agrees very well with Dejean's very common and widely spread species, found throughout South-East Asia and in Australia, but not in Japan.

3. **Apristus subtransparens** (p. 104).

One example only, with a " type " label, and another label, bearing the name, and in addition the words " I. or. Ceyl. Nura. Ell." The elytral striae are a little deeper than usual, but otherwise the type resembles the specimens identified by Bates. The species is a fairly common one in India and Ceylon, but has not hitherto been met with elsewhere.

4. **Mochtherus (Cyrtopterus) quadrinotatus** (p. 106) = *M. tetraspilotus*, Macl.,* 1825, Ann. Jav. 25.

Four examples, all more or less damaged, and all from Ceylon. Three of these are on one card; the fourth, which is on a separate card, bears a " type " label and the additional indication " Mt. N." (= Nuwara Eliya). Chaudoir's and Bates' identifications of this very common and much described species were correct. It seems generally to be found under bark.

5. **Dolichoctis (Belonognatha) quadriplagiata** (p. 106, t. 9, f. 4) = *D. marginifer*, Walk.,* 1858, Ann. Mag. Nat. Hist. (3), **2 :** 202 = *D. marginicollis*, Walk., 1859, Ann. Mag. Nat. Hist. (3), **3 :** 51. This confirms the synonymy already established.

Two examples on one card, bearing a name label, with the additional words " I. or. Ceylon M. !," and a " type " label; a third specimen on another card, with a similar label, is an example of *Mochtherus tetraspilotus*, Macl. (see No. 4).

Chaudoir in his " Mémoire sur les Coptodérides " identified Motchulsky's species correctly, but did not know either of Walker's. Bates identified it with *marginicollis*, Walk., but thought *marginifer*, Walk., another species. It seems to be confined to Ceylon, and, according to Bates, is found on fungi.

(ii) *Bull. Mosc.* **1864,** iii : 180–240.

6. **Patrobus flavipes** (p. 191).

In the solitary Japanese example, which must be regarded as the type, though it bears no label to that effect, the head and prothorax are missing. Judging by the elytra and hind body only, there seems no reason to doubt that the traditional identification is correct. The species seems to be a fairly common one in Japan and Eastern China.

7. **Ophonus (Graniger) algirinus** (p. 198) = *O. femoralis*, Coq.,* 1858 (1859), Ann. Soc. ent. Fr., (3) **6 :** 756 = *O. carteroides*, Fairm., 1868, Ann. Soc. ent. Fr., (4) **8 :** 475 = *O. olcesi*, Fairm., 1870 (1871), Ann. Soc. ent. Fr., (4) **10 :** 319.

A solitary specimen, in fairly good condition, labelled "Algiria." Chaudoir seems to have been the first author, in his "Monographie des Siagonides" (Bull. Mosc. **1876,** i : 118 and 124), to identify Motchulsky's genus *Graniger* with *Coscinia*, Dej. (1831, Spec. Gen. **5 :** 478) and *Cymbionotum*, Baudi (Berl. Ent. Z., **1864 :** 211), and the species *algirinus* and Baudi's *collare* (op. cit. p. 213) with his own *semelederi* (Bull. Mosc. **1861,** i : 6), these identifications were made without comment, or any suggestion that he had seen the types of either species, but they have been accepted by numerous later authors up to the present time.

I have in my own collection no example of the species, nor could I find one in the main collection of the British Museum, but in the palaearctic collection of the late Mr. G. C. Champion (now at the British Museum) I found a solitary unnamed specimen from "Port Baklar" (a locality I cannot trace), which agreed exactly with Motchulsky's type. This I took to Paris, where I compared it and found it to agree with the types of *femoralis* and *carteroides*, both in the Paris Museum; I have not seen the type of *olcesi*, which is I expect in Mr. René Oberthür's collection, and I insert this synonymy on the authority of Bedel's "Catalogue raisonné" (p. 141).

It follows from the above that *algirinus*, Motch., is a synonym of *femoralis*, Coq., while the name *Graniger* must replace *Carterophonus*, Gangl., as the subgenus under which this species and *O. cordicollis*, Serv., are placed. As *Coscinia*, Dej., is preoccupied and *Graniger* turns out to be something very different, the genus to which these two names have hitherto been applied must take the name of *Cymbionotum*, Baudi, and the group-name will be Cymbionotini. Thanks to Prof. U. Pierantoni, Director of the Zoological Museum, Turin, to whom I am much indebted for his kind assistance, I have been able to compare the type of *collare* with specimens of *semelederi*, and find that Chaudoir's hypothetical synonymy is in this case justified.

The species is found along both the northern and southern littorals of the Mediterranean, but does not seem to be a very common one.

8. **Cyclosomus marginatus** (p. 200) = *C. suturalis*, Wied.,* 1819, Zool. Mag. **1,** 3 : 169; Andr., 1921, Trans. Ent. Soc. Lond. **1921 :** 166.

This confirms the synonymy established in 1921. The solitary specimen, which bears a name label and the words "Ind. or.," is in a good state of preservation. Both Chaudoir and Bates recognised Motchulsky's species, but failed to identify it with Wiedemann's. It seems to be fairly widespread in Northern India, and Indo-China.

9. **Lebia retrofasciata** * (p. 227) = *L. japonica*, Chaud., Mon. des Lebiides (i), Bull. Mosc. **1870,** iii : 225 ; Bates, 1873, Trans. Ent. Soc. Lond. **1873 :** 318.

A single Japanese example in fair condition, the pale markings on the elytra rather slighter than usual. Chaudoir refers to, and had evidently correctly identified Motchulsky's species, but quite unwarrantably substituted a name of his own, which later on was also adopted by Bates. The species appears to be confined to Japan.

10. **Calleida rubricata** (p. 238) = *C. splendidula*, F., 1801, Syst. Eleuth. **1 :** 184, var. *rubricata*, Motch.

Three examples, all labelled " Ind. or." The name is applied to specimens in which the central red area on the elytra spreads beyond the two first intervals on each side. Both forms are found commonly throughout South-East Asia, sometimes at least under bark. The species is certainly predacious on *Hyblaea puera*, Cr., *Pyrausta machaeralis*, Walk., and *Nephopteryx rhodobasalis*, Hmpsn.

(iii) *Bull. Mosc.* **1864,** iv : 297–355.

11. **Anchomenus (Loxocrepis) coelestinus** * (p. 310) = *A. relucens*, Andr., 1923, Ann. Mag. Nat. Hist. (9), **12 :** 681.

A single specimen, in poor condition, and without head, labelled " Burma." Chaudoir was very fond, on quite inadequate grounds, of treating the species of other authors as synonymous with his own, and decided in this case to consider Motchulsky's species as identical with his own *Dicranoncus femoralis* (Bull. Mosc. **1850,** ii : 393). In *Dicranoncus*, as the name implies, the claws are bifid, which is not the case here. In view of the damaged and decrepit condition of the unique specimen, and especially the absence of the head, it is difficult to be sure of the identity of the species, but such parts as remain agree with the corresponding parts of my own *A. relucens*, which I accordingly treat as a synonym of *coelestinus*. The species is very common in Sikkim, but I have seen no other example from Burma.

12. **Anchomenus (Agonocyrthes) orbicollis** (p. 323) = *A. chinensis*, Boh.,* 1861, in Eugenie's Resa, Zool. Ins. **iv,** Col. : 15.

A solitary, rather broken example, not in good condition, bearing the label " Hong Kong," and also a round white label with the number 444; it evidently came from the Bowring collection, for similar examples in the British Museum bear the same round label and number. I am not aware of any previous attempt to identify the species, but fortunately have in my own collection an example already compared with Boheman's type, which agrees very well with Motchulsky's specimen.

Examples of this species have been found at Hongkong and in India, Ceylon, Indo-China, and Singapore.

13. **Trichisia cyanescens** (p. 332) = *T. morio*, Laf.,* 1851, Ann. Soc. ent. Fr., (2) **9 :** 221 (note 4) = *T. cyanea* Chaud. (not Schaum.), 1878, Ann. Soc. ent. Belg. **1878 :** 165.

A fairly good specimen labelled " Ind. or.," which in Motchulsky's case generally means India or Burma. Chaudoir, without giving any reason, or even inserting a mark of interrogation, put the species into synonymy with

T. cyanea, Schaum., from Hongkong. Actually it is confined to India; in my Catalogue "Sumatra" appears also as a locality, but the Sumatran examples prove to belong to a different, though closely allied species, since described under the name of *T. nesites*, Andr. (1931, Zool. Medd. **14** : 65).

14. **Dischissus** (**Peronomerus**) **quadrinotatus** (p. 333) = *D. notulatus*, F.,* 1801, Syst. Eleuth. **i** : 201.

A single example in rather a broken state. Although once again "Ind. or." is given as the locality, later authors have nevertheless identified Motchulsky's species with a Japanese insect. Bates in this case seems to be responsible for the misidentification; Chaudoir followed him, though without referring to Bates' paper, and the mistake was reproduced in my own Catalogue. I have now seen all the types of this much described insect, and the other cases of synonymy have already been dealt with. The species is found in India, Burma, the Malay States, Sumatra, and Southern China.

In the various typical examples the legs are pale and elytral interval nine black, but another form occurs, not apparently confined to any particular region, in which the tibiae and tarsi are black, while on the elytra the yellow colour of the front spot covers interval nine and extends to the epipleuron. For this form I suggest the name ***tibialis***, var. n.

The above considerations will leave *D. quadrinotatus*, Bates and Chaudoir (not Motchulsky), briefly described by the former and more fully by the latter, without any name; I propose for it ***japonicus***, nom. n., the type of which is in the British Museum.

(iv) *Bull. Mosc.* **1866,** i : 163–200.

15. **Trichotichnus** (**Platus**) **congruus** (p. 164). Har., 1877, Deuts. Ent. Z. **1877** : 338; Bates, 1883, Trans. Ent. Soc. Lond. **1883** : 237.

Five examples, of which three are in fair condition; in one of the other two specimens both head and thorax are missing. Two specimens bear name labels, with the additional word "Japonia," and to the better one, which happens also to be a ♂, I have added a "type" label. These specimens agree exactly with those taken by the late George Lewis and determined by Bates. The species, as far as I know, is confined to Japan.

(v) *Études Entomologiques*, ii, 1853.

16. **Pheropsophus marginicollis** (p. 44).

There is only one example, from "China bor.," in which the hind legs, apex of the elytra, and abdomen have been partly eaten away. Chaudoir's identification was accurate.

Motchulsky's description is brief and refers to the colour only, but Chaudoir has in his Monograph provided a detailed description. The type seems to be somewhat abnormal, for both the shoulder spot and the median fascia are very large, and they are more or less joined along costae 4, 5, and 6 (counting the sutural interval as the first costa), and along the marginal channel. In this the yellow colour is somewhat interrupted behind the median fascia, but it soon reappears and widens out, and, although the apex of the elytra has disappeared, it seems to have had a fairly wide yellow margin. The species appears to be confined to North China.

(vi) *Études Entomologiques*, vi, 1857.

17. **Anoplogenius (Megrammus) circumcinctus** (p. 27) = **A. cyanescens,** Hope,* 1845, Trans. Ent. Soc. Lond. **4 :** 15.

A single Japanese example, which serves to confirm the identification previously made. The species is a fairly common one in China and Japan. Owing to a misprint, my Catalogue gives the year of publication as 1859, instead of 1857.

18. **Selina westermanni** (p. 110, t. f. 6).

The antennae are broken, but otherwise the unique specimen is a fairly good one. On the label, which bears also the indication " Ind. or.," the generic name appears as " *Selida*," but the " d " seems to have been overwritten, and in any case it is printed as *Selina* in the description. There is no need to reproduce here the various other names which have been applied to this widely spread species by subsequent authors, as they have already been dealt with elsewhere.

(vii) *Études Entomologiques*, vii, 1858.

19. **Amblystomus (Hispalis) fuscescens** (p. 23). Bates, 1892, Ann. Mus. Civ. Gen. **32 :** 334; Lesne, 1904, Miss. Pavie, **3 :** 73; Andr., 1919, Trans. Ent. Soc. Lond. **1919 :** 198.

There are ten specimens, in a moderate state of preservation, and two fragments, all mounted on one card, with " Ind. or." on the name label. We know, however, from the description that the locality in this case is Burma. There are also numerous specimens of the species in the Prague Museum, taken nearly a hundred years ago by Dr. J. W. Helfer, and no doubt Motchulsky's examples came from this source; I have been able to compare with the type some of the Helfer examples, received from the Prague Museum, and find them to agree well.

Bates' determination is inaccurate; the two examples from Bhamo in the Genoa Civic Museum belong to a species nearly allied to *femoralis* and *pallipes*, but not quite agreeing with either of them.

Mr. Lesne's examples from Laos and Siam are also wrongly named; they belong to a much larger species than *fuscescens*, apparently undescribed, nearly related to *biguttatus*, but without elytral spots.

The specimen in the British Museum, to which I referred in the above quotation, came from the Walker collection and is labelled " Ceylon "; Walker no doubt received it from Motchulsky, and it was assumed to be in effect a cotype, but the label is in Walker's writing, and it turns out not to belong to the species at all. It is a very poor specimen, and apparently an example of *femoralis*. I now find that there is a second example in the British Museum, coming from the Jekel Collection, labelled " Ind. or." and with a name-label possibly in the author's writing; this also came from Motchulsky's collection, agrees entirely with the type, and was probably one of the examples taken by Helfer in Burma. There is another specimen in the Dresden Museum, possibly from the same source.

On the whole, the species fits the generic formula of *Amblystomus* as stated by Ganglbauer, and I am not here proposing any change, though the evenly rounded sides of the prothorax and uniformly brown elytra do not at first sight suggest that genus. The author's description, though the longest and most

detailed among the seven presented here, is both inadequate and inaccurate, and I am redescribing the species below.

Length: 3·5–4 mm. Head and prothorax piceous; elytra brown, with a faint aeneous tinge; palpi, joints 1 and 2 of the antennae, underside, and legs varying from flavous to dark ferruginous.

Head not so large as is usual in the genus, a slight impression on each side at the ends of the clypeal suture, clypeus bordered, moderately emarginate, but not asymmetrical, exposing to some extent the basal membrane of the labrum, which is emarginate, fringed with short pairs (apart from the 6 normal setae), and strongly asymmetrical, the left side projecting forward far beyond the right, eyes not prominent, adjoining buccal fissure, a single supra-orbital seta, mandibles short and wide, briefly hooked at apex, right one with a small sharp tooth, left one with a blunt tooth, mentum deeply emarginate, edentate, second joint of labial palpi with some minute accessory hairs in addition to the two normal setae, antennae fairly stout, extending rather beyond the base of the elytra. *Prothorax* moderately convex, a fifth wider than head and nearly a half wider than long, sides nearly evenly rounded, though the greatest width is slightly before middle, a single seta on each side at a third from apex, hind angles visible, though obtuse and strongly rounded; median line extremely fine, both transverse impressions quite distinct, basal foveae slight, base finely and rather sparsely punctate. *Elytra* moderately convex, not quite a half wider than prothorax, a little more than a half longer than wide, basal border entire, shoulders square, gently dilated behind and widest at a third from apex, which is subtruncate; striae rather fine, very vaguely crenulate, but deeper near apex, scutellary striole short, between 1 and suture, intervals rather flat, 3 with a pore towards apex, adjoining stria 2. The microsculpture of the elytra is reticulate, the meshes on average three times as wide as long, similar but a little finer on the prothorax, but near apex both elytra and prothorax have isodiametric meshes, as has the head. Prosternal process pilose; metasternal process bordered; metepisterna elongate; venter sparsely pilose, ♂ without any fovea at base, the apical segment on each side with two setae and an obtuse marginal tooth between them. Protarsi ♂ with 3 dilated joints; metatarsi not externally sulcate; joint 4 emarginate (not bilobed, as stated by the author); joint 5 with at least a pair of setae beneath. Aedeagus long and rather slender, dorsally channelled, slightly curved, and rather sharply pointed at apex.

20. **Amblystomus (Hispalis) aenescens** (p. 23).

There are two examples, both fairly well preserved, gummed on one card, one in front of the other; the name label also bears the words "Ind. or." The four lines of description which the author devotes to this species do not tell us much, but the two specimens are not exactly alike, and the description fits the front specimen better than the hind one, so that the former is here treated as the "type." After the description of *A. fuscescens*, Motchulsky says, in reference to the six remaining species, "Les autres espèces de ce genre, propres également au continent des Indes Orientales," from which it appears that he regarded Burma as part of the "Indian Continent," but there is no evidence to show the exact provenance of the present species. As, however, there are specimens in the Prague Museum, it seems almost certain that Motchulsky's examples came also from this source.

The type of *aenescens* is only 3 mm. long, so that it is smaller than any example of *fuscescens*. The visible characters, however, are very similar, though all the parts are a little narrower, the prothorax a little more contracted behind, and the elytra more finely striate.

A. chalceus, Andr., from Sumatra is closely allied, but is slightly larger, more evidently aeneous and with only the basal joint of the antennae pale, the clypeus evidently, though moderately asymmetrical, and the left lobe of the labrum less advanced.

21. **Amblystomus (Hispalis) femoralis** (p. 24). Bates, 1892, Ann. Mus. Civ. Gen. **32 :** 334; *id.* Ann. Soc. ent. Belg. **1892 :** 231.

Seven examples on one card, in fairly good condition, with a fragment of an eighth specimen. The name label bears also the expression "Ind. or.," and there is nothing to indicate a more precise locality, but, as there are numerous examples in the Helfer collection at Prague, no doubt these specimens came also from that source. There is an example from the Jekel collection in the British Museum.

In the paper first cited above Bates mentions two localities, but there are in the Genoa Civic Museum three examples, labelled Bhamo, Rangoon, and Palon respectively. The Palon example agrees well with the type, and the Bhamo specimen, though showing some differences, may be only a variety, but the example from Rangoon belongs to a larger and probably undescribed species.

In the second paper Bates gives no details, but there is in the Brussels Museum a specimen named *femoralis* by him, and presumably taken by Cardon in Chota Nagpur. It is a much larger insect than Motchulsky's, and I am not able to assign it to any hitherto described species.

It is possible that *femoralis* is identical with *guttula*, Dej., but I do not feel sure of this, for the specimen which I compared some years ago with Dejean's type did not quite agree with it, and a further examination is necessary to settle the point. I redescribe the species below.

Length: 3–3·5 mm. Colour black, in some specimens with a vague aeneous tint; palpi, joints 1 and 2 of the antennae, tibiae, and tarsi ferruginous, underside and femora piceous, though in the case of the femora this character is not by any means a constant one, for in some of the specimens the femora are as pale as the tibiae and tarsi. The first six specimens are placed in two rows of three each, and in the first example of the front row, which I treat as the type, the elytra have on each side near the apex a small ferruginous spot on intervals 4 and 5; in the remaining examples the elytra are unicolorous, and it appears that in the species of this genus, as sometimes in other genera, the presence or absence of an apical spot is not a specific character of any great importance.

Head rather massive, the clypeus slightly, the labrum rather more evidently asymmetrical. *Prothorax* slightly contracted behind, a fourth wider than head and quite a third wider than long, the sides and hind angles rounded, the transverse impressions fairly well marked, the basal area finely, but somewhat vaguely punctate. *Elytra* only slightly dilated behind, so that the sides are nearly parallel, about a third wider than the prothorax, three-fifths longer than wide, the shoulders square, the apex subtruncate; the three inner striae and the short scutellary striole are fine but distinct, the rest are faint or obsolete, 8 fairly deep behind and bearing some large punctures, the intervals flat, 3 with a small pore behind, adjoining stria 2. The microsculpture is as in *fuscescens*. Venter apparently without pubescence, nor are any setae visible on the underside of tarsal joint 5. In the ♂ protarsi joint 4 is slightly emarginate only and is hardly narrower than the preceding joints. The aedeagus is very narrow and sharply pointed at apex, much finer than in *fuscescens*. The species seems to be a very common one on the plains of India.

22. **Amblystomus (Hispalis) pallipes** (p. 24).

Six specimens in all. First three examples on one card, one in front (which I treat as the type), and two behind, bearing a yellow name-label, with the added words " Ind. or.," and a small white label with the locality " Birma," as in the case of *fuscescens*. Next a single example on a similar card and named in the same way, but without the " Birma " label. A fifth specimen is on a smaller piece of paper, without label, though furnished with a small circle of yellow paper. These five examples are similar, but the sixth, which is labelled like the fourth, is much larger than the rest, though it presents practically the same characters, and for the time being I treat it as belonging to the species.

These specimens, like those of *fuscescens*, probably came from Helfer's collection, though there is nothing but the " Birma " label to suggest this; there is, however, strong confirmation in the presence of numerous specimens in the Helfer collection at Prague. There is in the British Museum a specimen from the Jekel collection, bearing the label " *Hispalis pallipes* Motch. Ind. or.," possibly in the author's handwriting, and agreeing well with the type; from the way in which it is mounted it is evidently from Motchulsky's collection, and, as in the case of his examples, came almost certainly from Burma. Another specimen, very likely from the same source, is in the Dresden Museum. I redescribe the species below.

Length: 3·75–4 mm. (the large example is 5 mm. long). Upper surface black, the elytra sometimes with a faint brownish hue; palpi, joints 1 and 2 of the antennae and legs flavous; joint 3 of the antennae and metasternal region ferruginous; rest of antennae fuscous (not pale testaceous, as stated by the author).

Head large, frontal foveae obsolete, labrum very distinctly asymmetrical (at least in the type), but only slightly emarginate, clypeus on the other hand only slightly asymmetrical, but deeply emarginate, with a piceous border, the pale straw-coloured basal membrane of the labrum largely exposed, eyes small, antennae reaching well beyond the base of the elytra. *Prothorax* convex, subquadrate, a fourth wider than head, two-fifths wider than long, widest a little before middle, sides rounded in front, straight behind, the hind angles slightly reflexed, obtuse, and rounded, but quite evident; median line extremely fine, transverse impressions clearly marked, the small basal foveae rather indistinct, surface faintly transversely striate, base finely and vaguely rugose-punctate. *Elytra* subquadrate, moderately convex, two-fifths wider than prothorax and a half longer than wide, a little dilated behind and widest behind middle, shoulders square, apex sharply rounded rather than truncate; the inner 4 or 5 striae and the scutellary striole fine but distinct, and vaguely crenulate, the rest just visible, 8 rather deep behind, intervals flat, 3 with a fairly conspicuous pore adjoining stria 2, at a fourth from apex. On the elytra and prothorax the meshes of the microsculpture are on average about three times as wide as long; on the head they are isodiametric. Both pro- and meta-sternal processes are bordered, the former apparently glabrous; the surface of the venter is also glabrous, and no setae are visible on the underside of tarsal joint 5.

23. **Amblystomus (Hispalis) flavipes** * (p. 24) = *A. magnus*, Bates 1892, Ann. Mus. Civ. Gen. **32**: 333.

Four examples, three of them in moderately good condition, and a fragment, all on one card, and a fifth fairly good pinned specimen; the label in each case reads "*Hispalis flavipes* Motch. Ind. or.," and, as the species is known only from Burma, where it seems to be fairly common, it is highly probable that the source, as before, was Helfer's collection, especially as there prove to be numerous examples in the Prague Museum.

Bates recognised the similarity of his species to that of Motchulsky and mentions only some slight differences in colour, which he thought he had detected, to separate them. The descriptions of both authors are quite inadequate, but Mr. Fea, in the course of his Zoological excursion through Burma, collected many specimens, and the species is consequently a well-known one.

I will only add that the labrum is emarginate, and, in so far as it shows any asymmetry, it is the right side which is a little in advance of the left; the clypeus is moderately asymmetrical and widely, though not deeply, emarginate, just exposing the basal membrane of the labrum. The microsculpture of the elytra consists of extremely fine, closely placed lines, forming very wide meshes; on the prothorax the meshes are not quite so wide, and on the head they are isodiametric. The prosternal process and the venter both show traces of fine pubescence; the metasternal process is bordered, and the metepisterna are nearly twice as long as wide. Tarsal joint 5 has at least one pair of setae on the underside. The aedeagus is fairly wide at base, slightly curved, and tapers rapidly at apex to a very fine point.

24. **Amblystomus (Hispalis) quadriguttatus** * (p. 24). Bates, 1889, Ann. Soc. ent. Fr., (6) **9** : 271 (*guttula*, Dej.); *id.* 1891, Compt. rend. Soc. ent. Belg. **1891** : 331 (*indicus*, Nietn.); *id.* 1892, Ann. Mus. Civ. Gen. **32** : 336 (*indicus*) = *A. guttatus*, Bates, 1873, Trans. Ent. Soc. Lond. **1873** : 327; *id.* 1892, Ann. Mus. Civ. Gen. **32** : 336; *id.* 1892, Ann. Soc. ent. Belg. **1892** : 231.

There are nine examples on one card, arranged in two rows of five and four respectively, and labelled "*Hispalis* 4-*guttatus* Motch. Ind. or." I treat the first example in the front row as the type; the first example in the second row is a good deal larger than the other specimens and possibly belongs to another species. In addition there are the hind bodies of two other specimens, mounted on separate cards. There are numerous examples in the Prague Museum, so that these specimens were no doubt taken by Helfer in Burma.

In the first three quotations given above Bates identifies specimens with *indicus*, Nietn., which he regarded as a synonym in the first case of *guttula* and in the other two of *quadriguttatus*. It seems clear that he was unacquainted with Nietner's species, which is quite distinct from anything else described, and all his identifications with *indicus* are consequently erroneous. In *indicus* the whole of the upper surface is covered by a deeply engraved isodiametric microsculpture; in *bivittatus*, Andr., and *resectus*, Andr., the microsculpture is also isodiametric throughout, but the lines are finer and the meshes larger; *dromioides*, Bates, is superficially similar to *indicus*, but the lines of the microsculpture are also much finer and on the prothorax the meshes are transverse.

The first of the above references has been introduced because, although not labelled *quadriguttatus*, the first of the three specimens, now in the Fleutiaux collection (Paris Museum), which came from Saigon, bears a strong resemblance to Motchulsky's species; the size is the same, and it is quadriguttate, but there are differences both in it and in the other two specimens (Saigon and Hué), which lead me to think it is distinct, nor does it seem likely to be identical with *guttula*.

The specimen referred to in the second quotation, now in the Brussels Museum, was presumably taken by Cardon in Chota Nagpur; the head is missing, but otherwise it agrees exactly with *quadriguttatus*. There are also other similar specimens.

Compared with the type, the specimen from Palon, referred to in the third

quotation, is rather large and the pale spots on the elytra are both larger and more rounded; the clypeus too is a little more symmetrical and more deeply emarginate. The microsculpture, however, is identical, and I treat the example as belonging to Motchulsky's species, with the individual peculiarities mentioned.

In the British Museum there is an example from the Jekel collection, labelled "Ind. or.," and with a name-label possibly written by the author himself; this specimen, which evidently came originally from Motchulsky, agrees well with the type, apart from the clypeus, which resembles that of the Palon specimen. The species seems to be a common one in India and Burma, but I have thought it as well to redescribe it.

Length: 3–3·5 mm. Black, shiny; palpi, joints 1 and 2 of antennae (rest piceous), and legs (the femora sometimes infuscate) ferruginous; two flavous oval spots on each elytron, the front one on intervals 5 to 7, the hind one on intervals 3 to 5.

Head large and wide, frontal foveae slight, labrum and clypeus both slightly asymmetrical and a little emarginate, the basal membrane of the labrum sometimes a little exposed, clypeal suture distinct, eyes not prominent, antennae reaching well beyond base of elytra, mandibles massive. *Prothorax* convex, subquadrate, about a sixth wider than head, a half wider than long, widest before middle, sides rounded, hind angles evident, though obtuse, rounded and somewhat reflexed; median line very fine, transverse impressions both distinct, basal foveae obsolete, disk with some slight, irregular, transverse striae, basal area vaguely rugose-punctate. *Elytra* convex, nearly a third wider than prothorax, and nearly a half longer than wide, slightly dilated behind and widest at about apical third, shoulders square, apex subtruncate; striae very vaguely crenulate, the four inner ones rather lightly impressed, the outer ones faint, though visible, 8 fairly deep behind and also visible behind shoulder, intervals nearly flat, 1 narrowed and raised towards apex, 3 with a pore adjoining stria 2 at about a fourth from apex. Microsculpture on the elytra formed by very distinct meshes, on average about twice as wide as long; on the disk of the prothorax the meshes are finer and wider, but in front and behind they are hardly wider than long; on the head the meshes are isodiametric. Prosternal process to some extent, metasternal process conspicuously bordered; metepisterna quite twice as long as wide; ventral surface with traces only of pubescence at base and sides; tarsal joint 5 with a pair of setae beneath. Aedeagus as in *femoralis*, but not quite so sharp at apex.

25. **Amblystomus (Hispalis) biguttatus** (p. 25). Bates, 1889, Ann. Soc. ent. Fr., (6) **9**: 271 = *A. vulneratus* Dej.,* 1831, Spec. Gen. **5**: 852 = *A. tetrastigma*, Bates, 1892, Ann. Mus. Civ. Gen. **32**: 335.

Two similar examples, mounted one behind the other on the same card, of which I treat the front one as the type. The label reads "*Hispalis biguttatus* Motch. Ind. or.," but there is also a yellow label reading "Tranqu.," and we know from the description that these examples, received from Westermann, came from Tranquebar.

There are several Burmese specimens in the Helfer Collection at Prague and I have seen various examples from India, Ceylon, Siam, and Indo-China, but of those mentioned by Bates in the above reference only one, from Saigon, agrees with the type. I have in my collection an example compared some years ago with the type of *vulneratus* and have also before me the example from Rangoon determined by Bates (1892, Ann. Mus. Civ. Gen. **32**: 336). Bates' *tetrastigma*, of which I have a cotype, differs only in having a shoulder as well as an apical spot on the elytra, and I don't know why he should have described it as distinct. I give some account of the species below.

Length: 5·5–6 mm. Black; palpi, joint 1 of the antennae, and legs ferruginous (the femora hardly darker than the tibiae and tarsi, though the author says "cuisses rembrunies"), each elytron with a small round flavous spot near apex, on intervals 4 and 5.

Head massive, frontal foveae obsolete, labrum both asymmetrical and emarginate, clypeus only a little asymmetrical, with the front margin bordered and moderately emarginate, exposing the basal membrane of the labrum, eyes rather flat, antennae slender, not extending far beyond the base of the elytra. *Prothorax* convex, the outline of the sides and base forming approximately three-fifths of a circle, but with the base slightly flattened, a fifth wider than head and a little more than a half wider than long, the side margins narrowly reflexed, the hind angles just perceptible; median line extremely fine, front transverse impression distinct but shallow, hind one somewhat deeper, base slightly and finely rugose-punctate. *Elytra* moderately convex, rather more than a third wider than prothorax, nearly three-fifths longer than wide, slightly dilated behind and widest at apical third, shoulders square, apex sharply rounded; striae fine, vaguely crenulate, 5 to 7 faint, 8 deep behind and in front, where there are some large punctures, shallow at middle, intervals flat, 3 with a single small pore near apex, adjoining stria 2. Microsculpture reticulate and rather fine; on the elytra the meshes on average are about twice as wide as long; on the disk of the prothorax they are finer and wider, but in front and behind they are hardly wider than long; on the head the meshes are isodiametric but rather faint. Prosternal process bordered between the coxae; metasternal process bordered, the metepisterna bordered and much longer than wide; venter with only traces of pubescence; tarsal joint 5 with a pair of setae beneath. Aedeagus similar in form to that of 4-*guttatus*.

After examining a good many examples of this species and 4-*guttatus*, I find differences in specimens of each, not only in size and colour, but in the form of the labrum and clypeus, and even in the elytral microsculpture, which make it exceedingly difficult to discriminate between them, and it seems quite possible that there may be only one widely spread and very variable species.

(viii) *Études Entomologiques*, viii, 1859.

26. **Risophilus (Tetragonica) fuscus** (p. 28, t. 1, f. 2).

Three specimens in moderate condition on one card, and fragments of about four more on a second card, all from "Nuwara Eliya." A well-known Singhalese species; I have not seen the specimens referred to by Putzeys, but Bates correctly identified the late George Lewis' examples.

27. **Allocota viridipennis** (p. 30). Chaud. Bull. Mosc. **1877,** ii: 205.

Two examples, apparently ♂ and ♀, and both in a fair state of preservation. On both name-labels appear the words "Ind. or. Java," in one case with and in the other without a mark of interrogation after "Java." Each specimen also bears a minute round yellow label, one (♂) with the letter "J" (presumably Java), and the other (♀) "Cel." (possibly Celebes).

Motchulsky's description is longer and more detailed than usual. Chaudoir supposed he had recognised the species, and he gives a very full account both of it and of the genus, recognising only one point of difference, namely the depth of the elytral striae. Actually, although agreeing in so many particulars, the two species are quite distinct. *A. viridipennis* is a little the larger, but otherwise differs chiefly in the colour and form of the elytra. In the ♂ these are bright green, cupreous at the sides behind; in the ♀ they are blue on the disk and in the marginal channels, but bright green elsewhere. In Chaudoir's species the elytra are blue, with only traces of green. Again in *viridipennis*

the elytra are roughly sculptured, and the striae deep, as are the punctures in them, and the seriate pores on intervals 3, 5, and 7, which here and there occupy half the interval, the intervals moderately convex, 6 and 7 bulging out and forming a boss behind. In Chaudoir's species the surface of the elytra is smooth and even, the striae and punctures, including those on the intervals, very fine, intervals 6 and 7 only a little raised behind. As this species has no alternative name, I propose the new one of ***A. caerulea***, the type of which is in Mr. R. Oberthür's collection.

Motchulsky gives a curious account of the antennae and venter. In the ♂ specimen the apical joints of the antennae are now missing, and the last joint of the only complete antenna in the ♀, which as he says is " En forme de bouton," is evidently abnormal. In both sexes the venter has the usual six segments.

A. caerulea has been found in Singapore, Borneo, Sumatra, and the Philippine Is., but *viridipennis* seems to be confined to Java. I have seen only one other specimen, found at Depok, which the Director of the Buitenzorg Museum has kindly presented to me. This is a ♀, with normal antennae, coloured exactly like Motchulsky's ♀ specimen, and differing only in being a trifle smaller.

28. **Diceromerus (Stomonaxus) orientalis** (p. 36).

One well-preserved specimen from Tranquebar. The species, which is widely spread through South-East Asia, has been generally recognised and does not call for any special comment.

(ix) *Études Entomologiques*, ix, 1860.

29. **Ophonus (Platus) rugicollis** (p. 5).

There is only one specimen, in fairly good condition, with the author's yellow label, bearing the name and the word " Japonia."

Motchulsky four years later (Bull. Mosc. **1864**, iii : 213) informs us that *Ophonus* (*Harpalus*) *japonicus*, Moraw., is identical with his own *rugicollis*. This was later verified, for he sent a cotype of his species to Harold (1875, Abh. Nat. Ver. Bremen **4** : 285), who found that it corresponded exactly with Morawitz's long description. Bates has several notes on the species (Trans. Ent. Soc. Lond., **1873** : 261; **1876** : 3; and **1883** : 236), and assured himself of the synonymy by sending a specimen of *japonicus* to Chaudoir, who returned it after comparison with a " type " of *rugicollis*. The species has since been identified with *Ophonus* (*Harpalus*) *sinicus*, Hope.

Nevertheless Motchulsky's " type " proves to be an example of *Anisodactylus punctatipennis*, Moraw. The description is of the slenderest kind, and, up to a point, fits both species, but the dimensions given are widely different, and the expression " antennis pedibusque rufo-testaceis " appears to settle the question. In view of this and the circumstances detailed above, there seems little doubt that some interchange of labels has taken place, and that the specimen now in question is not that which the author had before him when drawing up his description.

30. **Pterostichus (Poecilus) planicollis** (p. 5) = *P. caerulescens*, L.,* Syst. Nat. Ed. X. 1758, p. 416.

One fairly good example, a second with the head and prothorax missing, and only fragments of a third, all from Japan. I cannot distinguish the first

specimen, treated here as the type, from Linnaeus' very variable species, which seems to range throughout the whole of the palaearctic region, but of which I have not seen the type. Motchulsky's type is cupreous, the antennae with the three basal joints dark red (not "articulis duobus primis rufo-testaceis," as given by the author), the head rather finely and closely punctate, the base of the prothorax with the impressions small, and the puncturation scanty.

31. **Lesticus (Omaseus) magnus** * (p. 5) = *L. ingens*, Moraw., 1863, Mem. Ac. Imp. Sci. St. Petersb. (7), **6,** No. 3 : 54.

A single Japanese example in good condition. The synonymy was established by Chaudoir in his "Révision des Trigonotomides," and has never been in question. I have not seen the types of Morawitz. The species seems to be common in Japan and Eastern China.

32. **Pterostichus (Omaseus) japonicus** (p. 6) = ? *P. prolongatus*, Moraw., 1863, Bull. Ac. Imp. Sci. St. Petersb. **5 :** 251.

A fragment of one specimen only, but with a "type" label attached. The head and prothorax have disappeared; a large part of the hind body is also missing, and all that remains consists of the basal third of the elytra, the meso- and metasterna, the basal half of the abdomen, and the two hind pairs of legs. The mesepisterna, sides of metasternum, inner margins of metepisterna, and sides of the basal ventral segments are more or less finely punctate; the tarsal joints are outwardly sulcate, and joint 5 is setulose beneath. Motchulsky's name is the older one, but there is not enough of the type left to settle the question of synonymy, so that, unless an authentic specimen turns up elsewhere, Morawitz's name must be used.

33. **Pterostichus (Platysma) subovatus** (p. 6).

A single Japanese specimen, marked as "type"; the antennae and palpi have practically disappeared, but otherwise the specimen is in fair condition.

This is a common East Asiatic species, which has often been referred to, and which seems never to have presented any difficulties in determination.

34. **Pterostichus (?Argutor) microcephalus** * (p. 6). Bates, 1873, Trans. Ent. Soc. Lond. **1873 :** 285 and **1883 :** 250; Chaud. Bull. Mosc. **1878,** iii : 63 = *P. nimbatus*, Moraw., 1863, Bull. Ac. Imp. Sci. St. Petersb. **5 :** 325; id. 1863, Mém. Ac. Ins. Sci. St. Petersb. (7), **6,** No. 3 : 48.

Two Japanese specimens, one only bearing a label, and neither of them marked as type; apart from the somewhat defective antennae, both examples are in a fair state of preservation. Motchulsky later on (Bull. Mosc. 1865, iv, p. 261) proposed for his species the subgenus *Rhagadus*.

In his earlier paper Bates, with some hesitation, put the two species named above into synonymy, but Chaudoir, judging from Motchulsky's very imperfect description, disagreed with this view and, in his second paper, Bates followed Chaudoir. In his second paper quoted above Morawitz gives a very full description of his species, with which Motchulsky's specimens agree very well indeed, so that the name of *microcephalus* must stand.

The species is apparently fairly common in Japan and North-East Asia.

35. **Pterostichus (Orthomus) subaeneus** (p. 6) = *P. aberrans*, Moraw.,* 1863, Bull. Ac. Imp. Sci. St. Petersb. **5 :** 251.

Two Japanese specimens, one bearing a type label, and both in very fair condition. The synonymy here has been long established, and the species referred to Motchulsky's subgenus *Badistrinus*, but, his name being preoccupied, Morawitz's name must be used. According to Tchitcherin (1893, Hor. Soc. Ent. Ross. **27 :** 479) *P. sagax*, Motch. (Bull. Mosc. **1865**, iv : 259) from the Amur region is identical. He was evidently judging by the description, but specimens in my collection from the Amur mouth differ from *aberrans* in having a much deeper outer sulcus on each side at the base of the prothorax, bounded by an external ridge, the sides of the base being also more strongly punctate, and the elytra having a very distinct, if short, scutellary striole. This form may prove to be *P. sagax*, of which I have not seen the type.

36. **Pristodactyla arcuaticollis** (p. 7). Bates, 1873, Trans. Ent. Soc. Lond. **1873 :** 274.

Three Japanese examples, all in moderately good condition, one of them bearing a " type " label. I have before me one of the specimens determined by Bates, which is a little smaller than Motchulsky's specimens, but on the whole agrees fairly well. As far as I know, the species is confined to Japan.

37. **Colpodes (Tanystola) japonicus** (p. 8).

The solitary Japanese specimen has one antenna left, and has lost the two hind pairs of legs, and the abdomen. It bears the name *Batenus japonicus*, Motch., the subgenus having been proposed by him later on (Bull. Mosc. **1864**, iv : 317) for this and some other allied species. It has been identified by various authors, and, in so far as I can form an opinion on what remains of the type, I think correctly. The type is rather a narrow specimen, the pale margin of the prothorax also narrow, the elytra green, with only the border and suture ferruginous.

(x) *Études Entomologiques*, x, 1861.

38. **Harpalus (Pheuginus) corporosus** (p. 3). Bates, 1873, Trans. Ent. Soc. Lond. **1873 :** 265 and **1883 :** 238 ; Tchitch., 1906, Hor. Soc. Ent. Ross. **37 :** 256 and 257 note (5).

Two Japanese examples, both in moderately good condition; the first bears both name and " type " labels, and agrees very well with the specimens in the Lewis collection determined by Bates. The second, which has no label, is an example of *H. discrepans*, Moraw. Motchulsky appears to have mixed the two species, for he considered *discrepans* as synonymous with his own *corporosus* (Bull. Mosc. **1864**, iii : 214), a circumstance commented on by both Bates and Tchitcherin. The species is found in Eastern Asia and Japan.

39. **Ophonus (Pseudophonus) cephalotes** (p. 3) = *O. capito*, Moraw.,* 1863, Bull. Ac. Imp. Sci. St. Petersb. **5 :** 259.

Although only the hind body of a single specimen remains, there does not seem much doubt about the identification of this well-known species. In addition to the name label, with the word " Japan " added, the pin bears a " type " label. Motchulsky's name is the older, but is preoccupied. The species appears to be common in North-Eastern Asia and Japan.

40. **Crepidactyla nitida** (p. 5). Moraw., 1863, Mém. Ac. Imp. Sci. St. Petersb. (7), **6,** No. 3 : 39 ; Bates, 1873, Trans. Ent. Soc. Lond. **1873 :** 273.

The unique specimen is from Japan, and bears both name and " type " labels. Unfortunately only the hind body remains, but this agrees exactly with the same part of one of the specimens determined by Bates, the size, form, and iridescence of the elytra being exactly similar. So far therefore as it is now possible to judge, Bates' identification is accurate, and both he and Morawitz seem to have recognised the species without difficulty.

(xi) *Études Entomologiques*, xi, 1862.

41. **Lachnothorax biguttata** * (p. 50) = *L. oculata*, Chaud., Bull. Mosc. **1862,** iv : 291.

Two fairly good specimens, one of them upside down, on a single card, accompanied by both name and " type " labels. " Ind. or." appears on the label, but in the description the locality is said to be " Tranquebar." I have compared with the type a specimen from the same region in my own collection ; this had already been compared with the type of *oculata*.

Chaudoir, following Gemminger and Harold's catalogue, rejected Motchulsky's genus, but the late Mr. T. G. Sloane, with whom I quite agree, has lately reinstated it.

(xii) *Insectes de la Sibérie*, 1844.

42. **Metabletus (Dromius) fuscomaculatus** (p. 59).

There are six examples, five of them in fair condition, mounted on three pieces of talc ; one of the locality labels reads " L[ac] Goktscha," and the other two " Elisabethpol " [Armenia], but there is no " type " label.

I asked to see the type of this species because I believed it to occur commonly in the Himalayas. As mentioned by Bedel, the area of distribution is a very large one, extending from the Canary Is. to Persia, and both in form and colour there is considerable variation. Motchulsky's Armenian specimens are small (3·75 mm.), the elytra more or less piceous, the humeral and apical spots pale ferruginous, and widely separated. Himalayan specimens are larger (4·25 mm.), the elytra black, the humeral and apical spots nearly white, and uniting, as Bedel says, to form two stripes rather like exclamation marks. Nevertheless, I hesitate to regard them as more than a local form.

43. **Pterostichus (Steropus) orientalis** (p. 151, t. 7, f. 2). Tchitch., 1896, Hor. Soc. Ent. Ross. **30 :** 337.

Three examples, labelled Nertschinsk, Dauria, and Kuluke Bad (?) respectively ; only one bears a name label, viz. " Steroderus orientalis mihi Nertschinsk," and there is no " type " label. Of two of these specimens only parts of the hind body remain ; the third, from Kuluke Bad, is in moderate condition and I have attached a type label to it.

The species is well known in North-East Asia and Japan, and in the paper referred to above Tchitcherin has given a full account of it. Mr. Lutshnik gave the species a new name (1914, Rev. Russ. Ent., **14 :** 427) on the ground that Motchulsky's name was preoccupied, but he failed to support the proposed change by citing the name of the antecedent author.

44. **Harpalus cervicis** (p. 197, t. 9, f. 2). Tchitch., 1906, Hor. Soc. Ent. Ross. **37** : 257.

Eight examples, of which seven are in moderate condition, the eighth having lost the head and prothorax. None of them bears a type label, but there are various locality labels, viz. " Mongol," " Kiachta," and " Davuria."

The species is very nearly allied to *H. salinus*, Dej. (1829, Spec. Gen. **4** : 341) and, although in the paper referred to above Tchitcherin does not say he has seen the type, there seems to be no doubt about his identification. In Winkler's palaearctic catalogue Motchulsky's species is treated, no doubt correctly, as a synonym of *lumbaris*, Dej. (1829, Spec. Gen. **4** : 352), but I have no personal knowledge of this.

The area of distribution is a wide one, extending from Siberia, through Eastern China, to Tibet.

(xiii) *Die Käfer Russlands*, 1850.

45. **Pterostichus (Argutor) orientalis** (49 note 1). Moraw., 1863, Bull. Ac. Imp. Sci. St. Petersb. **5** : 250; Motch. Bull. Mosc. **1865,** iv : 255 = *P. orientis*, Csiki * (nom. nov.) 1930, Col. Cat. pars **112,** Carab. Harpal. iv : 617.

The author described two species under the name of *orientalis*, both belonging to the genus *Pterostichus*, and the examples of this one came to me with those of No. 43. Both species are exclusively palaearctic, and I am dealing here chiefly with those of South-East Asia, but as the specimens are before me, and the species now in question has never been satisfactorily identified, it seems desirable to give some account of them.

There are four specimens :—(i) a ♂ example in rather moderate condition labelled " Argutor orientalis Motch. Sib. or.," and with a locality label " am fl. Uda "(?). This I treat as the " type." (ii) A second example, evidently belonging to another species, with only a locality label " fl.— " (undecipherable). (iii) Head, prothorax, and a fragment of the hind body of a third specimen, labelled " fl.— " (undecipherable, but differing from (ii)). (iv) Hind body only of a fourth example, labelled " Gallia."

Morawitz put the species in synonymy with his own *crassicollis*, a statement subsequently denied by Motchulsky. I have in my collection two named examples of *crassicollis* from different sources, agreeing with each other, and with the description. Motchulsky is right, for his species is evidently a different one. My examples of *crassicollis* average 7·75 mm. in length, whereas the type of *orientalis* is barely 7 mm. long, and also differs from *crassicollis* in the following particulars. Head narrower and eyes flatter. Prothorax with the sides a little more strongly rounded, the hind angles and puncturation of the base similar, but there is only one sulcus on each side, and the short carinae in the angles, so conspicuous in *crassicollis*, are wanting. The border of the elytra forms an angle at the shoulder, but it is not dentate, the striae are finer and shallower, with hardly a trace of crenulation, the scutellary striole is normally developed, and there are three dorsal pores on interval 3. The microsculpture is isodiametric, as in *crassicollis*, and the tarsal joints are not sulcate.

Note.

While this paper was in the press, Mr. Kuzin discovered and sent me for examination two of the types hitherto treated as lost, viz. :—

(i) **Brachinus longicornis,** Motch. in Schrenk, 1860, Reis. Col., p. 92, t. 6, f. 13 = *B. stenoderus,* Bates,* 1873, Trans. Ent. Soc. Lond., **1873 :** 305 = *B. macrocerus,* Chaud., Monographie des Brachynides, 1876, Ann. Soc. ent. Belg., **19 :** 67.

A single specimen in moderate condition, with " Sib. or. fl. Amur " on the name label; an examination of this serves to confirm the synonymy already practically established. Bates did not know Motchulsky's species, but evidently thought it identical with his own; he was right in any case in giving it a new name, as *longicornis* was preoccupied. Chaudoir's later attempt to impose a third name was quite unjustified.

(ii) **Patellus (Coelostoma) flavipes,** Motch.,* Bull. Mosc., **1865**, iv : 228; Chaud. Bull. Mosc. **1869**, ii : 392 = *Patellus drimostoides,* Chaud., 1882, Ann. Soc. ent. Fr., (6) **2 :** 553.

A single specimen in fair condition with " Ind. or." on the yellow name label and a further small white label reading " Birma," this locality, however, not being mentioned in the description.

Chaudoir mentions the species in his "Essai monographique sur le genre *Abacetus*," quoted above; he did not know Motchulsky's species, but thought it probably identical with *Abacetus* (*Distrigus*) *dejeani,* Nietn. Chaudoir gives " Birmanie " as the locality in the case of his *P. drimostoides,* and, although there appear to be no specimens in the Prague Museum, it may be suspected that both his and Motchulsky's examples came from the Helfer collection.

INDEX

Abacetus dejeani, Nietn., 18.
Agonocyrthes orbicollis, Motch., 4.
Allocota caerulea, nom. nov., 13.
,, *viridipennis,* Motch., 12.
Amblystomus genus, 1.
Amblystomus aenescens, Motch., 7.
,, *biguttatus,* Motch., 11.
,, *bivittatus,* Andr., 10.
,, *chalceus,* Andr., 8.
,, *dromioides,* Bates, 10.
,, *femoralis,* Motch., 8.
,, *flavipes,* Motch., 9.
,, *fuscescens,* Motch., 6.
,, *guttatus,* Bates, 10.
,, *guttula,* Dej., 8, 10.
,, *indicus,* Nietn., 10.
,, *magnus,* Bates, 9.
,, *pallipes,* Motch., 9.
,, *quadriguttatus,* Motch., 10.
,, *resectus,* Andr., 10.
,, *tetrastigma,* Bates, 11.
,, *vulneratus,* Dej., 11.
Anchomenus chinensis, Boh., 4.
,, *coelestinus,* Motch., 4.
,, *orbicollis,* Motch., 4.
,, *relucens,* Andr., 4.
Anisodactylus punctatipennis, Moraw., 13.
Anoplogenius circumcinctus, Motch., 6.
,, *cyanescens,* Hope, 6.
Apristus subtransparens, Motch., 2.
Argutor microcephalus, 14.
,, *orientalis,* 17.
Badistrinus subgenus, 15.
Batascelis ceylonicus, Motch., 2.
Batenus japonicus, Motch., 15.
Belonognatha quadriplagiata, Motch., 2.
Brachinus longicornis, Motch., 18.
,, *macrocerus,* Chaud., 18.
,, *stenoderus,* Bates, 18.
Calleida rubricata, Motch., 4.
,, *splendidula,* F., 4.
Carterophonus subgenus, 3.
Coelostoma flavipes, Motch., 18.
Colpodes japonicus, Motch., 15.
Coscinia genus, 3.
Coscinia semelederi, Chaud., 3.
Crepidactyla nitida, Motch., 16.
Cyclosomus marginatus, Motch., 3.
,, *suturalis,* Wied., 3.
CYMBIONOTINI group, 3.
Cymbionotum genus, 3.
Cymbionotum collare, Baudi, 3.
Cyrtopterus quadrinotatus, Motch., 2.
Diceromerus orientalis, Motch., 13.
Dicranoncus genus, 4.
Dicranoncus femoralis, Chaud., 4.
Dischissus japonicus, nom. nov., 5.
,, *notulatus,* F., 5.
,, ,, var. *tibialis* var. nov., 5.
,, *quadrinotatus,* Motch., 5.
Distrigus dejeani, Nietn., 18.
Dolichoctis marginicollis, Walk., 2.
,, *marginifer,* Walk., 2.
,, *quadriplagiata,* Motch., 2.

Dromius fuscomaculatus, Motch., 16.
GRANIGER genus, 3.
Graniger algirinus, Motch., 3.
Harpalus cervicis, Motch., 17.
,, *corporosus*, Motch., 15.
,, *discrepans* Moraw., 15.
,, *japonicus*, Moraw., 13.
,, *lumbaris*, Dej., 17.
,, *salinus*, Dej., 17.
,, *sinicus*, Hope, 13.
Hispalis aenescens, Motch., 7.
,, *biguttatus*, Motch., 11.
,, *femoralis*, Motch., 8.
,, *flavipes*, Motch., 9.
,, *fuscescens*, Motch., 6.
,, *pallipes*, Motch., 9.
,, *quadriguttatus*, Motch., 10.
Lachnothorax biguttata, Motch., 16.
,, *oculata*, Chaud., 16.
Lebia japonica, Chaud., 4.
,, *retrofasciata*, Motch., 4.
Lesticus ingens, Moraw., 14.
,, *magnus*, Motch., 14.
Lozocrepis coelestinus, Motch., 4.
Megrammus circumcinctus, Motch., 6.
Metabletus fuscomaculatus, Motch., 16.
Mochtherus quadrinotatus, Motch., 2.
,, *tetraspilotus*, Macl., 2.
Omaseus japonicus, Motch., 14.
,, *magnus*, Motch., 14.
Ophonus algirinus, Motch., 3.
,, *capito*, Moraw., 15.
,, *carteroides*, Fairm., 3.
,, *cephalotes*, Motch., 15.
,, *femoralis*, Coq., 3.
,, *japonicus*, Moraw., 13.
,, *olcesi*, Fairm., 3.
,, *rugicollis*, Motch., 13.
,, *sinicus*, Hope, 13.
Orthomus subaeneus, Motch., 15.
Pachytrachelus ceylonicus, Motch., 2.
Pachytrachelus oblongus, Dej., 2.
Patellus drimostoides, Chaud., 18.
,, *flavipes*, Motch., 18.
Patrobus flavipes, Motch., 3.
Peronomerus quadrinotatus, Motch., 5.
Pheropsophus marginicollis, Motch., 5.
Pheuginus corporosus, Motch., 15.
Platus congruus, Motch., 5.
,, *rugicollis*, Motch., 13.
Platysma subovatus, Motch., 14.
Poecilus planicollis, Motch., 13.
Pristodactyla arcuaticollis, Motch., 15.
Pseudophonus cephalotes, Motch., 15.
Pterostichus aberrans, Moraw., 15.
,, *caerulescens*, L., 13.
,, *crassicollis*, Moraw., 17.
,, *japonicus*, Motch., 14.
,, *microcephalus*, Motch., 14.
,, *nimbatus*, Moraw., 14.
,, *orientalis*, Motch. (1844), 16.
,, ,, ,, (1850), 17.
,, *orientis*, Csiki, 17.
,, *planicollis*, Motch., 13.
,, *prolongatus* Moraw., 14.
,, *sagax*, Motch., 15.
,, *subaeneus*, Motch., 15.
,, *subovatus*, Motch., 14.
RHAGADUS subgenus, 14.
Risophilus fuscus, Motch., 12.
SELINA genus, 6.
Selina westermanni, Motch., 6.
Steropus orientalis, Motch., 16.
Stomonaxus orientalis, Motch., 13.
Tanystola japonica, Motch., 15.
Tetragonica fusca, Motch., 12.
Tetragonoderus notaphioides, Motch., 2.
Trichisia cyanea, Chaud., 4.
,, *cyanescens*, Motch., 4.
,, *morio*, Laf., 4.
,, *nesites*, Andr., 5.
Trichotichnus congruus, Motch. 5.

ATTACKS OF BIRDS ON BUTTERFLIES

By G. D. Hale Carpenter, M.B.E., D.M.

Hope Professor of Zoology (Entomology), Oxford University.

[Read 7th December, 1932.]

With Plate I.

The constant stress laid by opponents of the explanation of Mimicry as due to selective action by birds renders it important for supporters to produce evidence of attacks by birds on butterflies.

The thirty-one specimens here described are the result of minute examination of each of many thousands of specimens collected on the Sesse Isles, L. Victoria, without any thought at the time whether they did or did not show beak-marks. The collection was chiefly made by the writer, but the specimens collected by Mr. and Mrs. W. C. Simmons in 1926 were also examined (1927, (1928) *Proc. Ent. Soc.* Lond., **2**: 60). Especial attention was paid to collecting every specimen possible of the mimetic Nymphaline, *Pseudacraea eurytus*, L.; including 26 collected by Mr. and Mrs. Simmons there are 613, among which 9 show clear beak-marks.

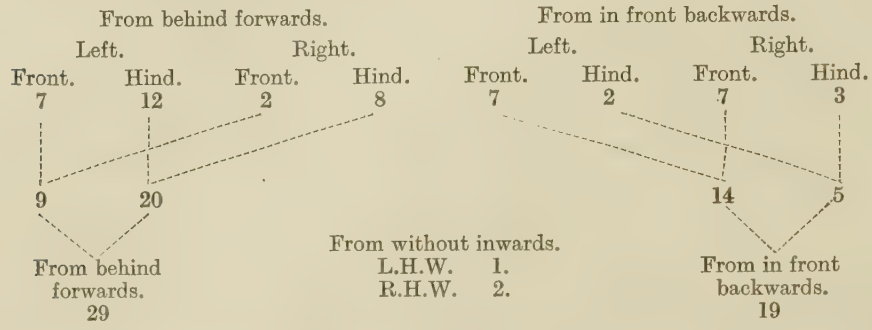
The characteristics by which the marks are judged to have been made by beaks are :—

(1) ∧-shape. (2) Presence on both surfaces of the wing. (3) A bare spot of greater degree of rubbing, sometimes perforating the membrane, at the apex. (4) Position such that it *could* have been made by a beak. (5) The end of each limb of the ∧ at the wing-margin often corresponds with a notch in the margin. (6) The limb of the ∧ nearest the body may be more rubbed than the other, suggesting, as Mr. Collenette pointed out (1928, *Trans.*, **76**: 398), that the butterfly has flapped the wing while held.

It will be noted that there is no Papilionine and only one Pierine among the thirty-one, and no Satyrine. But Pierines were very scarce on Sesse, and neither of the other two groups was collected as intensively as Nymphalines and Acraeines. It is interesting that specimen No. 29 is the only one collected on the minute islet of Zigunga; such minute islets are often mere reefs of rock and sand with a few herbs growing on which the larvae of Lycaenids feed. Wagtails may often be seen on the sand, where the butterflies settle to drink, and it was expected that the mark on this *Hypolycaena* would correspond with a Wagtail's beak; but it is more like that of a Flycatcher.

Some of the specimens bear evidence of repeated attacks by the same type of bird (possibly the same bird), such as Nos. 6, 11, 19, 28 on the plate, while others, such as 7, 15, 20, show marks of different birds. When analysed for direction the marks do not yield any decisive evidence that attack is more often from in front or behind, when the attack is made during flight and one wing, or the wings of one side only, have been seized. But they do show very decisively that attack is more often from in front or behind, seldom from the

side, and, in cases where it appears that both wings have been gripped when closed together (Nos. 7, 14, 16, 31) the attack has been from behind, which is what would be expected if the insect were settled. The following table shows the direction of the marks.



This gives the position of 51 marks. As these are paired in four cases (Nos. 7, 14, 16, 31) the true number of separate attacks is 47.

It is difficult to understand why in some cases the beak, whose imprint is so clearly impressed, has done so little harm to the wing, particularly when, as in Nos. 1, 15, 20, the attack has been from the margin of the hind-wing. It does not seem possible that the butterfly escaped by flapping its wing, and another explanation is necessary. Prof. W. T. M. Forbes, of Ithaca, with whom this point was discussed, suggested that there might be analogy with his own experience when picking moths out of a light trap by seizing a wing with forceps. Often, at the moment of closure of the forceps on a wing, the moth escaped, and it is suggested that there is a momentary rebound of one blade from the other which allows a wing to be extricated with little injury.

Through the kindness of Dr. P. R. Lowe of the British Museum, a skull of a Bee-eater (*Melittophagus*) was obtained, which Dr. H. Eltringham, F.R.S., kindly fitted up so that a bite could be inflicted on the wings of a butterfly. The result of one such is shown labelled " Bee-eater " on the plate, made on a living specimen of a " Meadow-Brown " butterfly.

Dr. Lowe also most kindly sent tracings of marks made by beaks of African birds and said, " the method adopted was to pass paper between the upper and lower mandible, and then after pressing the tomium, or cutting edge, of the former on the paper, we traced round it with a fine-pointed pencil." Reproductions made by taking tracings of these drawings are shown from 1–28 on the accompanying plate. These can be compared with the series A–Z and A′–K′ which are reproductions of the marks described in the following list, drawn to careful measurements with fine-pointed dividers.

It will be seen that in many cases coincidence is sufficiently close to allow the supposition that a certain mark on a wing is probably due to a certain genus of bird.

The method of preparation of series 1–28 has probably resulted in slight exaggeration of the width of the markings, but the correspondence can still be very close.

Certain marks, A, B, B′, J′, K′, do not quite coincide with any of 1–28.

Butterfly.	Nature and direction of mark.	Figure of the mark.	Mark corresponds with—
1. PIERINAE. *Catopsilia florella*, F., ♂. 7.ii.14. Kome.	R.H.W. from costal angle inwards to tip of cell. The margin torn at the anterior limb.	I.	25, 26. Flycatcher (*Terpsiphone viridis*).
2. DANAINAE. *Danaida chrysippus chrysippus*, L., ♂. 9.ii.14. Dwanga Mto.	L.F.W. from hind margin forwards.	T.	25, 26.
3. DANAINAE. *Amauris damocles psyttalea*, Plötz, ♂. 27.iv.14. Kimmi.	R.H.W. from anal angle forwards, through scent brand.	V.	1. Yellow-billed Roller (*Eurystomus afer*). 19. Wagtail (*Motacilla vidua*). 21. Wagtail (*Motacilla cinerea*).
4. NYMPHALINAE. *Pseudacraea eurytus tirikensis*, Neave, ♀. 8.vi.14. Ngamba.	R.F.W. from costa backwards, just internal to end of cell.	H.	13. Roller (*Coracias abyssinicus*).
5. Do. Do. 2.i.19. Dwanga Mto.	R.H.W. from costal angle towards anal angle.	Z.	15, 16. Bee-eater (*Melittophagus pusillus*).
6. *Pseudacraea eurytus terra*, Neave, ♂. 10.viii.12. Bugalla.	1. L.F.W. from mid costa outwards and backwards. Bare spot at apex, and membrane punctured. 2. L.F.W. from costa just external to pale subapical bar, outwards and backwards to a tear in area 4. The outer half of L.H.W. is shorn off anterior to the internervular ray in area 3.	G. G (part).	25, 26. Flycatcher (*Terpsiphone viridis*).
7. *Pseudacraea eurytus terra*, Neave, ♂. 23.viii.14. Kome.	Both H.W. forwards from hind margin, not quite symmetrically disposed. Better marked on L. Apex surrounded by rubbed area. Wing-margins slightly torn at limbs of the mark.	A (two).	Does not correspond with any of the beak-marks reproduced.
	L.H.W., within A, from hind margin forwards and inwards.	M.	17, 18. Wagtail (*Motacilla flavus*).
8. *Pseudacraea eurytus terra*, Neave, ♀. 20.viii.14. Kome.	R.H.W. along hind margin, obliquely forwards from vein 3. From area 3 to area 5 wing-margin broken away; only inner limb of ∧ shown except at apex.	U.	3. Roller (*Eurystomus afer*).
9. *Pseudacraea eurytus terra*, Neave, ♂. 7.xii.18. Kome.	R.H.W. costal angle torn away to middle of area 6. Mark directed from inner edge of tear backwards and inwards. Rubbed spot at apex.	N.	13. Roller (*Coracias abyssinicus*).
10. *Pseudacraea eurytus terra*, trans. to *tirikensis*, Neave, ♀. 16.vi.12. Bugalla.	L.F.W. backwards from costa through pale subapical bar. Rubbed spot at apex.	F.	13. Roller (*Coracias abyssinicus*).

Butterfly.	Nature and direction of mark.	Figure of the mark.	Mark corresponds with—
11. *Pseudacraea eurytus terra*, trans. to *tirikensis*, Neave, ♀. 10.ix.12. Bugalla.	L.F.W. from middle of hind margin forwards and inwards across cell to costal margin. The apex is not shown. L.H.W. has been shorn away in front of tip of cell: the edge that is left corresponds with inner limb of beak-mark. R.F.W. torn away posterior to vein 3 at its middle, and R.H.W. torn along whole hind margin and costal angle.	G′.	7. Bee-eater (*Merops pusillus*). 10. Bee-eater (*Merops apiaster*).
12. *Pseudacraea eurytus obscura*, Neave, ♂. 15.viii.14. Kome.	Greater part of L.H.W. missing. Mark commences at torn edge, directed forwards into cell. A second mark on L.F.W. directed forwards, its inner limb corresponding with torn edge of H.W. is probably, but not unmistakably, due to another type of bird.	J.	25, 26. Flycatcher (*Terpsiphone viridis*).
13. Nymphalinae. *Mesoxantha ethosea*, Drury, ♂. 25.xii.18. Damba.	R.H.W. shorn away anterior to vein 3. Mark on R.F.W. from hind margin forwards, the inner limb corresponding with shorn edge of H.W. Apex at costa which is cracked.	C.	25, 26 (as above).
14. Nymphalinae. *Precis milonia rauaua*, Smith, ♂. 23.vii.12. Bugalla.	Both H.W. forwards and slightly inwards from just external to root of tail. On R. it is slightly nearer mid-line.	H′.	7, 8. Bee-eater (*Melittophagus bullockoides*. 9, 10. Bee-eater (*Merops apiaster*).
15. Acraeinae. *Planema aganice montana*, Btlr., ♂. 8.v.14. Kimmi.	Four different marks on H.W.		
	1. R.H.W. from costal angle inwards and slightly backwards. Rubbed spot at apex. Posterior limb corresponds with a piece shorn out of hind margin.	D.	25, 26. Flycatcher (*Terpsiphone viridis*).
	2. R.H.W. from anal angle forwards and outwards to vein 3. Tip of mark in missing part of hind margin.	S.	27, 28. Flycatcher (*Batis minor nyanzae*).
	3. L.H.W. from hind margin at vein 4–5 backwards to anal angle.	R.	25, 26. Flycatcher (*Terpsiphone viridis*).
	4. L.H.W. from same point as 3, but forwards along margin to costal angle.	W.	1, 2. Roller (*Coracias caudatus*).
16. Do. Do. ♂. 6.xii.18. Tavu.	R.F.W. Two from costa backwards in outer half of wing. Peculiarly rounded apices.	I′.	9, 10. Bee-eater (*Merops apiaster*).
17. Do. Do. ♀.	L.F.W. from middle of outer margin forwards and inwards. Posterior limb more strongly marked.	J′.	Like A and B. Does not correspond with any beak-mark reproduced.

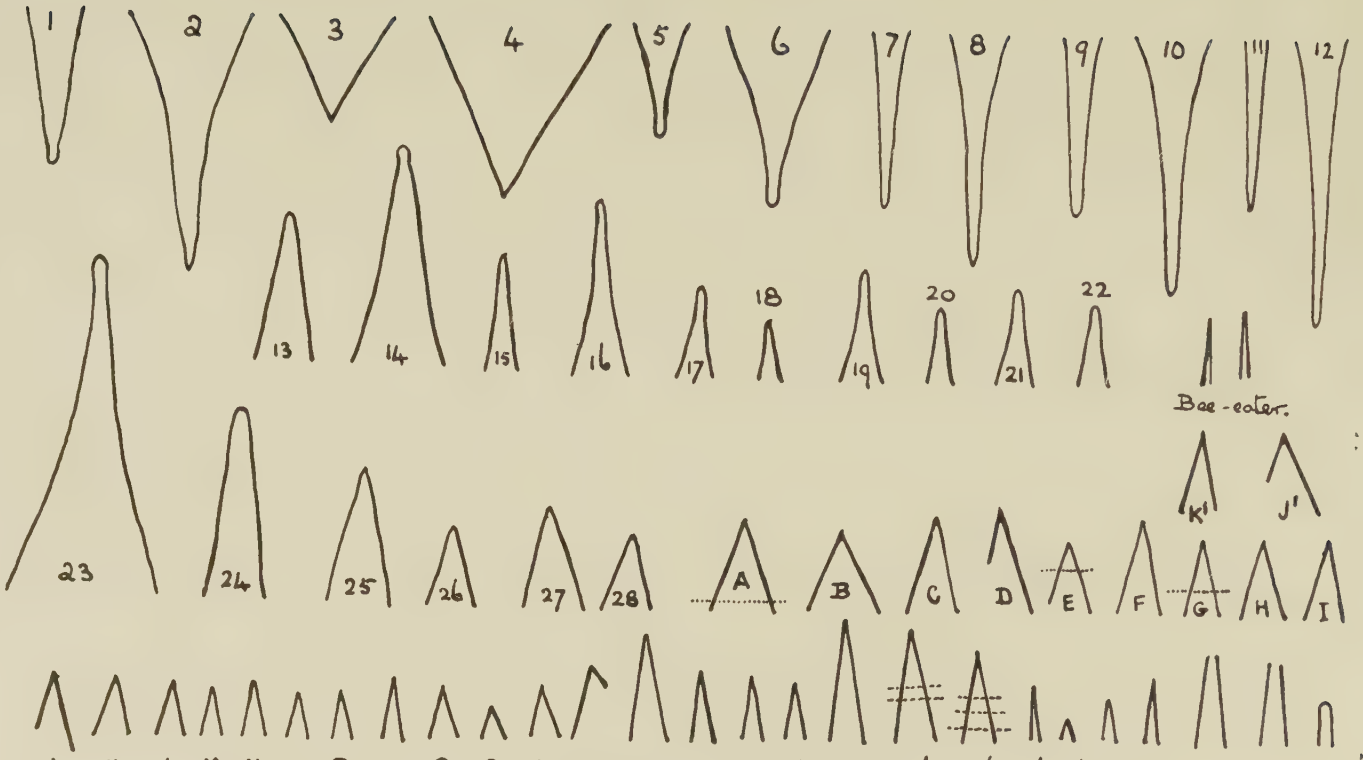
Butterfly.	Nature and direction of mark.	Figure of the mark.	Mark corresponds with—
18. *Planema macarista*, E. Sharpe, ♀.	L.F.W. Three from middle of hind margin forwards, inclined to slightly different directions.	K′.	13. Roller (*Coracias abyssinicus*), but apex is sharper.
19. *Planema tellus eumelis*, Jord., ♂. 7.vi.14. Kome.	Three on R. side. 1. F.W. from costa outwards and backwards just external to pale subapical bar. 2. F.W. from costa outwards and backwards across middle of cell. 3. H.W. from middle of costa outwards and backwards.	A′.	1, 2. Roller (*Coracias caudatus*).
20. *Acraea lycoa entebbia*, Eltr., ♂. 16.xii.18. Bulago.	Three on L. side. 1. F.W. from costa backwards just external to tip of cell. Rubbed spot at apex.	E.	27, 28. Flycatcher (*Batis minor nyanzae*).
	2. H.W. from costal angle inwards.	E.	Do.
	3. H.W. from costa backwards towards anal angle. Inner limb more marked. Posterior margin of F.W. broken opposite each limb.	B.	Very near 3 and 4, but does not quite correspond.
21. *Acraea servona rhodina*, Rthsch., ♂. Aug. 1926. Kome. W. C. Simmons.	L.H.W. from hind margin along area 2. Rubbed spot at apex.	F′.	11, 12. Bee-eater (*Merops persicus*).
22. *Acraea orina orineta*, Eltr., ♂. 31.i.14. Ngamba.	L.F.W. from costa backwards and outwards through end of cell.	Q.	18. Wagtail (*Motacilla flavus*). 22. (*Motacilla cinerea*).
23. *Acraea terpsichore rougeti*, Guér., ♂. 25.i.14. Nsadzi.	L.H.W. from behind forwards and inwards along vein 3.	P.	18.22. Do. Do.
24. *A. t. rougeti*, as above. Aug. 1926. Kome. W. C. Simmons.	L.H.W. from behind forwards across vein 4.	O.	18, 22. Do. Do.
25. *Acraea egina*, Cr., ♂. 18.i.14. Kome.	Three on L. side. 1. F.W. from base of area 4, backwards and outwards: rubbed spot at apex.	X.	18, 22. Do. Do.
	2. F.W. from base of area 3, cutting across first mark, to margin at vein 2. Apex outside wing.	Y.	18, 22. Do. Do.
	3. H.W. at costal angle. One limb only, from area 6 to end of vein 7: rubbed spot at end.		
26. Do. Do. ♂. 17.xii.18. Tavu.	Both hind-wings. R. broken away behind vein 5; end of beak-mark like that on L. runs forward from the torn margin. L. forward from anal angle.	K.	25, 26. Flycatcher (*Terpsiphone viridis*).
27. Do. Do. ♀. 7.iii.14. Bulago.	L.H.W. forwards along area 1 C.	C′.	11, 12. Bee-eater (*Merops persicus*).

Butterfly.	Nature and direction of mark.	Figure of the mark.	Mark corresponds with—
28. *Acraea zetes jalema*, Godt., ♂. 19.ii.14. Kiuwa.	Several marks of same type on R. side.		
	R.F.W. has extremity of area 2 torn out and R.H.W. is torn away internal to area 2. 1. R.F.W. from costa backwards just external to cell. Costa cut through at end of vein 12. 2. R.F.W. from anal angle forwards and inwards, a rubbed spot surrounds apices of this and 1. 3. R.H.W. from hind margin forwards, each limb corresponding with a tear in the margin. Inner limb more strongly marked. Rubbed spot at apex. 4. R.H.W. from costal angle backwards along hind margin.	B′.	These, like K′, agree with 13 except that apex is sharper. Roller (*Coracias abyssinicus*).
29. Lycaenidae. *Hypolycaena philippus*, F., ♂. 20.ii.14. Zigunga.	R.F.W. from costa near apex backwards. Outer limb more marked.	L.	25, 26. Flycatcher (*Terpsiphone viridis*).
30. *Cupido hippocrates*, F., ♂. 16.ii.14. Lukalu.	L.F.W. from hind margin forwards.	D′.	Too short to be adequately compared.
31. *Cupido gaika*, Trim., ♂. 18–20.ii.14. Kibibi.	Both H.W. from anal angle forwards, symmetrical. Hind margins irregularly torn.	E′.	11, 12. Bee-eater (*Merops persicus*).

Explanation of Plate I.

Figs. 1–28 represent marks made by beaks of known African birds.
Figs. A–Z, A′–K′ represent marks on wings of captured butterflies.

Figs. 1, 2. *Coracias caudatus.*
3, 4. *Eurystomus afer.*
5, 6. *Ceuthmocharis aeneus.*
7, 8. *Melittophagus bullockoides.*
9, 10. *Merops apiaster.*
11, 12. *Merops persicus.*
13, 14. *Coracias abyssinicus.*
Figs. 15, 16. *Melittophagus pusillus.*
17, 18. *Motacilla flavus.*
19, 20. *Motacilla vidua.*
21, 22. *Motacilla cinerea.*
23, 24. *Coracias naevia.*
25, 26. *Terpsiphone viridis.*
27, 28. *Batis minor nyanzae.*



Types of beak-marks from butterfly wings.

TWO-HORNED SPHINGID LARVAE (A RECESSIVE MUTATION)

By E. A. Cockayne, D.M., F.R.C.P., and C. N. Hawkins.

[Read 7th December, 1932.]

With Plate II.

In the *Entomologist* of February 1930 Frohawk figures a two-horned larva of *Sphinx ligustri*, L. It was one of twenty, all with the second horn more or less developed. They were probably all bred from the eggs of a single female sent to Mr. J. P. Lloyd, but unfortunately other females bred from normal larvae had laid their eggs in the same box, so that this could not be proved. The record led the late Mr. Randall Parkes to publish the discovery of a similar larva of *ligustri* found with eleven normal ones on a privet bush near the Norfolk coast in 1927, a locality in which Mr. Charles de Worms tells us he himself had found two-horned larvae in the previous year. Mr. O. Howard also wrote and said that he took a pair of *Amorpha populi*, L., in Hyde Park and that from the eggs laid eighty larvae hatched and twenty-five of them had two well-developed horns, though most of them had their horns bitten short as they grew older. The only previous mention of a two-horned larva of *ligustri* is that given by Tutt, who says that shortly before his book was published, Mr. V. E. Shaw exhibited one at a meeting of the City of London Entomological Society, but we have been unable to find a reference to it in their Transactions. The only example of *populi* known before appears to be the preserved larva from Brighton, which is in the Walsingham collection at the British Museum, but it is evident from the correspondence elicited by Frohawk's note that the condition cannot be as rare as the paucity of records suggests.

The Nature of the Abnormality.

The larva of *ligustri* in its first instar is provided with setae, which show the arrangement of the somites. The seventh abdominal somite has the anterior and posterior trapezoidals (α and β of Fracker) on raised green tubercles situated on the third and sixth subsegments respectively as shown in Pl. II, fig. 4; on the eighth somite according to Poulton the horn is formed by the fusion and great elongation of the tubercles carrying the anterior trapezoidals, but according to Tutt it is the bases of the tubercles that are fused and elongated and the tubercles themselves have disappeared. It is however possible that the two conical elevations, each surmounted by an anterior trapezoidal seta, seen on the blunt tip of the horn are the true tubercles. These are shown in Pl. II, fig. 5. In the larva of *populi* in its first instar the horn ends in the same way. Immediately behind that part of the somite carrying the horn there is a small transverse fold on which the two posterior trapezoidals are situated. In a normal larva of the first instar a larger fold behind this carries two pairs of setae, the anterior and posterior trapezoidals of the tergite of the ninth somite, and the sternite of the ninth lies slightly more posteriorly and carries only one seta visible from the lateral aspect. The tenth consists almost entirely of the anal flap and prolegs. Sharp thinks that this part of

the larva is formed by both ninth and tenth abdominal somites and appears to have mistaken the ninth for a portion of the eighth.

The two-horned larva in its first instar (Pl. II, fig. 6) differs in having a rather longer tergite to the ninth abdominal, which carries a horn instead of the two anterior trapezoidals. This horn almost always divides into two fairly long terminal portions each carrying on its extremity one of the anterior trapezoidal setae. The second horn is usually much more curved downwards than the first and is often twisted to one side or the other, but it has the same colouring as the normal horn, being much paler proximally on the lateral than on the dorsal and ventral surfaces. The extent of this pale area varies, but the second horn is always a close copy of the first in this respect and like the first it is clothed throughout its length with minute hairs each shaped at the tip like a fish's tail. As the larvae grow the second horn usually becomes less and less bifid, and in many cases in the last instar it becomes single and sharp-pointed like the normal horn of the preceding somite. In the extent of black and pale colouring it continues to copy the first horn. Occasionally the first horn is entirely black as in the larva shown in Pl. II, fig. 11, and the second horn in this larva was also entirely black. Very rarely the second horn is bifid from its extreme base and remains so even in the last instar as in the larva shown in Pl. II, fig. 11, and it is not uncommonly as bifid as in the larva shown in Pl. II, fig. 12. In a larva sent by Mr. Frohawk the second horn is bifid, asymmetrical, and irregular in outline, 2 mm. wide from tip to tip and 2 mm. long, while the normal horn is 10 mm. long. In the larva in its first instar the first horn is 3 mm. long while the second is only about 1 mm. long. In the adult larva the second horn varies much in length and thickness; in some it is more than half as long as the normal horn and in others it is only just visible, though on an average it is about a third the length of the first horn. The second horn is bent sharply downwards and sometimes to one or other side, and the first horn too is often bent a little to the right or left.

In the adult larva the division between the eighth and ninth somite is very difficult to make out. The blown larvae of *populi* kindly lent by Mr. Howard show no division except on the dorsum, nor did a blown normal larva. The ninth abdominal is very long in the larva seen in fig. 2, but the horns have both been partially eaten by another larva. No trace of the division could be seen in a living larva of *ligustri*, and, but for a first-instar larva to indicate its position, it could not have been determined in the specimen preserved in spirit sent by Mr. Frohawk. In the blown larvae of *ligustri* it is fairly distinct, and it can be seen that the sternite of the ninth abdominal is relatively shorter than in the first instar and occupies a slightly more anterior position. The tenth consists of a dorsal fold over the anal flap, the flap itself, and the prolegs.

The seventh oblique purple stripe in many adult larvae of *ligustri* is carried on to the eighth somite to the base of the horn, but in others it ends at the posterior border of the seventh and is continued on to the eighth as a dark green stripe. In none of the two-horned larvae is there any trace of an eighth oblique purple stripe. Some normal larvae have a transverse line of purple colouring just anterior to the horn, and if this is present in a two-horned larva there is a similar but smaller purple line in front of the second horn. It was present in the larvae shown in Pl. II, figs. 10 and 12. There is never any trace of a spiracle on the ninth abdominal in the abnormal larvae.

The nature of the abnormality is quite clear. It is an example of homoeosis, the ninth abdominal somite possessing some of the characters of the eighth, both structural and pigmentary, and is of more than usual interest, because it

occurs in a wild state and is no less vigorous than the ordinary form of larva. The nearest parallels are the two mutations of *Drosophila melanogaster*, Bithorax and Bithorax-b, described by Bridges and Morgan, in which the metathorax is more or less changed in structure to a second mesothorax. Both these mutations are recessive, but they show an unusual ratio believed to be due to the action of an environmental factor in addition to the genetic one.

We had little doubt that the two-horned condition in the Sphingid larvae was also inherited, but the brood of *populi* obtained by Mr. Howard giving a ratio of 25 : 55, abnormal to normal larvae, and the wild larvae of *ligustri* found by Mr. Parkes on one bush giving a ratio of 1 : 12 (accepting his assumption that all were the offspring of one female) were neither the 1 : 3 ratio of a recessive nor the 1 : 1 ratio of a dominant. In the hope of proving whether the condition is recessive or dominant one of us, E.A.C., wrote to Mr. Howard asking him to try and carry on the strain. Unfortunately he had not kept the pupae of the two-horned larvae separate from the one-horned, and as the moths emerged over a long period, he had only one opportunity of getting a pairing. The pairing was successful and took place on 2.viii.1930, resulting in 103 ova, but, although most of them were fertile, only 57 hatched and all had a single horn. As it seemed probable that these were heterozygous they were very carefully looked after and kept in sleeves in the house with a view to crossing them *inter se* the next year. They were delicate and only 24 reached maturity. The imagines emerged at long intervals; only once was there a male and female alive at the same time, and then the female was moribund, so that the strain was lost.

Having failed with *populi* we hoped for better luck with *ligustri* and obtained a few two-horned larvae from Mr. Lloyd. He had kept no exact records of his broods, but said that from a pairing between parents both from two-horned larvae he always got about 99 per cent. of larvae with two horns. No doubt all were two-horned, but those with only a small oval green patch in place of the second horn in the last instar, such as the one in Brood D mentioned later, were regarded as normal. In addition to the pupae from these two-horned larvae we had seven pupae from normal larvae collected at Box Hill and three from Southsea given by Mr. A. H. Sperring. One of us, C.N.H., procured two pairings between imagines of pure two-horned stock. The first took place on 5.vi.1931 and gave 97 ova. All those which hatched (Brood A) had the second horn well developed in the first instar. The second pairing gave only 11 ova, of which 3 hatched (Brood B). All three had the second horn, but it was very small and bifid. An attempt to pair a male from a two-horned larva with a female from Box Hill failed; a reverse cross probably succeeded, though the pairing was not seen, and resulted in 29 infertile ova. A male from a two-horned larva paired readily with a Southsea female, but no ova were laid, but a Southsea male and a female from a two-horned larva paired on 21.vi.1931 and gave us the required heterozygous larvae from the 95 ova laid (Brood C). One of us, E.A.C., took charge of the majority of them and of the two-horned larvae of Brood A. The larvae were sleeved out of doors at Tadworth, but the weather was very wet and both broods were attacked by disease, which affected the heterozygous larvae much more seriously than the two-horned ones. Luckily C.N.H. had kept 12 heterozygous larvae in the house and these did well.

Ultimately we had 41 pupae of Brood A, 22 ♂♂ and 19 ♀♀, of which 11 ♂♂ and 8 ♀♀ died during the winter, and 21 heterozygous pupae of Brood C, 9 ♂♂ and 12 ♀♀, of which 5 died during the winter and 3 remained dormant for another year.

C.N.H. again undertook the pairings, but encountered unexpected difficulties. Most of the two-horned brood emerged before the heterozygotes and only one pairing between a heterozygote (a male) and a two-horned one was possible and this failed. The females of the two-horned brood were restless and none of the seven pairings tried between them and males of the two-horned brood was successful, though cages were placed both out of doors and indoors near an open window. Pairings between heterozygous males and females also failed with one exception, which gave the results shown under Brood D in the subjoined table. This pairing took place on 26.vi.1932 and the female was the smallest of the brood. In one case a female was calling, but the two males in the cage remained quiescent. The failure to get pairings was unaccountable. Males and females emerged on the same day or within twenty-four hours of one another and yet they would not pair. Inbreeding cannot explain the difficulty with the heterozygotes, though it might account for the failure with the two-horned brood.

The following table shows the actual and theoretical results assuming that the two-horned condition is recessive.

1931.		Ova laid.	Hatched.	Developed but failed to hatch.	Infertile.	Two-horned.	Normal.
A	Two-horned × Two-horned	97	68		29	68	0
B	Two-horned × Two-horned	11	3		8	3	0
	Total					71	0
	Theoretical result					71	0
C	Southsea ♂ × Two-horned	95	92	1 and 1 lost	1	0	92
	Theoretical result					0	92
1932. D	Heterozygotes × Heterozygote C × C	81		3		60	18
	Theoretical result					58·5	19·5

Though the total number of pairings falls far short of what we had hoped for, three of the four kinds we wanted were obtained. That between an imago homozygous for the two-horned condition and a heterozygote, which should have given a ratio of 1 : 1, two-horned to one-horned larvae, is the only kind we did not get. We think our results will be accepted as sufficient to prove that the two-horned mutant larva is recessive to the normal one-horned larva

and that no environmental factor is concerned. There may be other genes modifying the size of the second horn. The larvae of Brood A showed great variation from very small to very large second horns, the three members of Brood B all had very minute second horns, while the great majority of the two-horned members of Brood D had large second horns. Two members of this brood, however, had very minute second horns, one had in the first instar a mere tiny black speck where the second horn should have been, and this speck became even less noticeable with each ecdysis owing to gradual loss of the black pigmentation, until in the full-grown larva it was reduced to a small transversely oval scar of the same green colour as the surrounding surface, and a few had the second horn short, broad, and bifid.

Pupae from two-horned larvae are normal except that they show a more or less distinct scar of the second larval horn on the dorsum of the ninth abdominal somite just above the base of the anal spine.

References.

Bridges, C. B., and Morgan, T. H. 1923, The Third-chromosome Group of Mutant Characters of *Drosophila melanogaster*. Publ. Carnegie Inst. Wash., **327** : 137, 225.

Frohawk, F. W. 1930, Entomologist, **63** : 39.

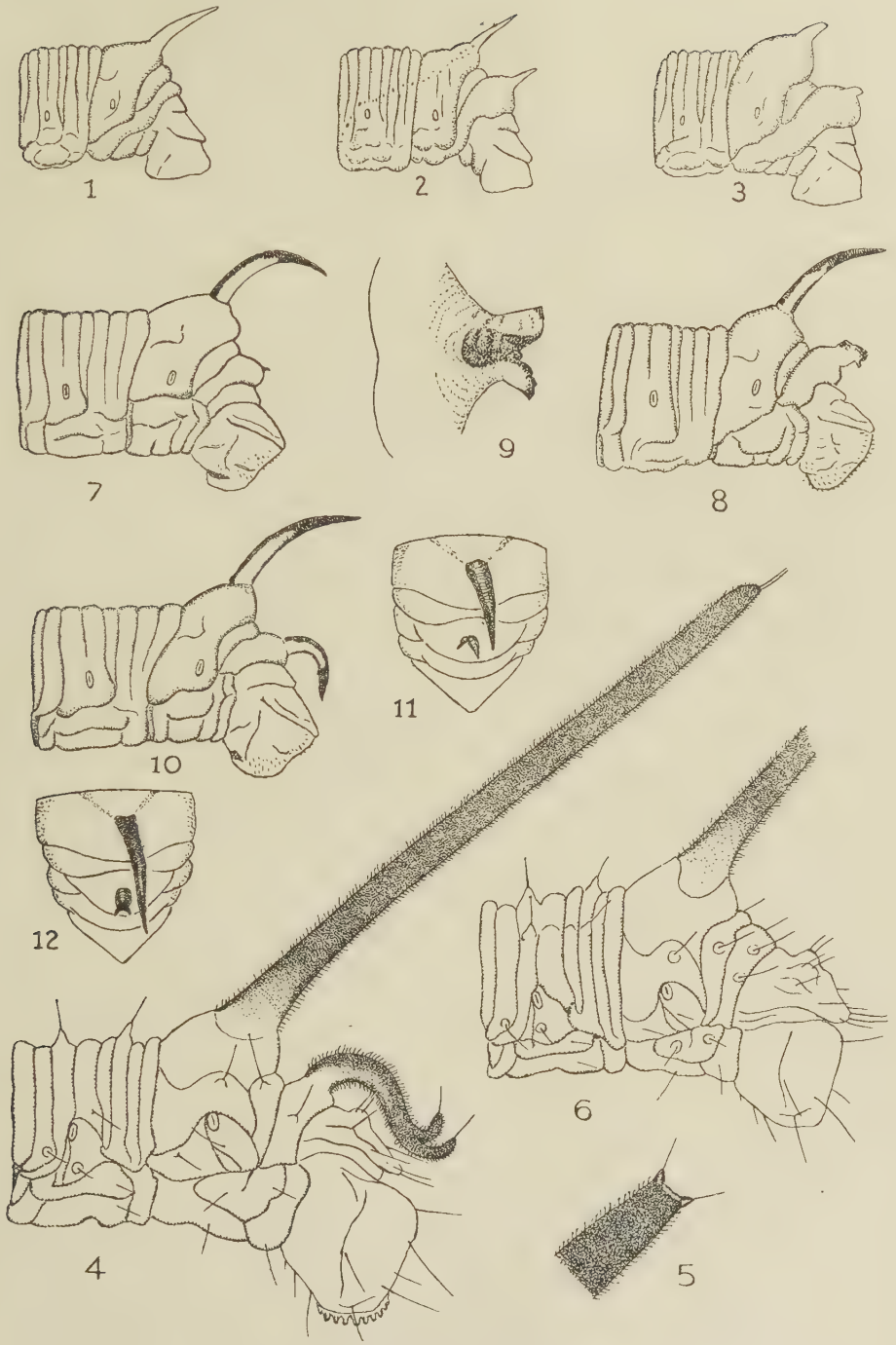
Howard, O. *Ibid.*, **63** : 87.

Parkes, W. Randall. *Ibid.*, **63** : 87.

Tutt, J. W. 1904, Brit. Lepidopt., **4** : 316.

Explanation of Plate II.

Fig. 1. Normal larva of *Amorpha populi*. (× 2.)
Figs. 2, 3. Two-horned larva of *A. populi*. (× 2.)
Fig. 4. Normal larva of *Sphinx ligustri*, 1st instar, dorso-lateral aspect. (× 33.)
5. Tip of horn of larva of *S. ligustri*, 1st instar, showing anterior trapezoidal setae.
6. Two-horned larva of *S. ligustri*, 1st instar, Brood D. (× 33.)
7. Larva of *S. ligustri* (Brood B) with very small second horn. (× 2.)
8. Larva of *S. ligustri* (Frohawk) with bifid second horn. (× 2.)
9. Bifid horn of the same larva, dorsal aspect. (× 6.)
10. Larva of *S. ligustri* (Brood A) with large second horn. (× 2.)
11. Larva of *S. ligustri*, last instar, with unusually bifid horn, dorso-posterior aspect. (× 2.)
12. Larva of *S. ligustri* with slightly bifid horn, dorso-posterior aspect. (× 2.)



Two-horned Sphingid larvæ.

ON THE TARSAL SENSE-ORGANS OF LEPIDOPTERA

By H. Eltringham, M.A., D.Sc., F.R.S.

[Read 5th April, 1932.]

With Plate III.

Professor Dwight E. Minnich of Minnesota in 1921 demonstrated that certain butterflies respond to various substances when these come into contact with the mid and hind tarsi. A full account of his experiments, repeated and extended more recently, would occupy considerable space, and it must suffice here to state that by ingenious methods he was able to prove that such insects as *Pyrameis atalanta*, *Vanessa antiopa*, and others could in this way distinguish between water and apple juice, and responded to weak solutions of saccharose, hydrochloric acid, quinine-sulphate and sodium-chloride. The responsiveness to sodium-chloride varies widely, and is apparently conditioned by varying physiological states of the insects themselves. Similarly, prolonged abstention increases the sensitivity to a surprising extent, and under certain conditions a butterfly could respond to a solution of saccharose, so weak as to indicate a sensitivity some 256 times that of the human tongue. Further experiment showed that certain Muscid flies possess the same faculty. The visible response of the insects concerned consisted in an extension of the proboscis, on tarsal contact with the experimental fluids. Amputation of the antennae and palpi does not inhibit the action, and we may therefore say, making a free use of a familiar term, that certain insects can *taste* with their feet.

It seems probable that chemoreceptors are of general occurrence in the distal parts of the legs of Arthropods, various investigators having demonstrated a chemical sensitivity in the legs of scorpions, lobsters, crayfish, and prawns.

I have been in communication with Professor Minnich on the subject, and he informs me that though some attempts have been made, in his laboratories and elsewhere, to discover the sense-organs involved they have not so far been successful, and he gave me every encouragement to make further investigations. Good sections are essential, but owing to the hardness of the chitin and the presence of numerous stout spines, the technical difficulties are rather formidable.

Technique.

I have made many experiments with the preparation known as "Diaphanol." For certain purposes it is extremely useful. It depigments and softens chitin in a remarkable way, but subsequent processes of dehydration and embedding restore its hardness, even if acetone be used in place of alcohol. Moreover, in spite of statements to the contrary, it does cause, in the softer tissues, changes which preclude accurate diagnosis of their histology. Of the many preparations I have made by other means few are really satisfactory, but the fact that some of them are good, shows that with care and patience, much may be done, even with such refractory material. However hard chitin may be, it becomes still harder in contact with pure alcohol. After several trials I

found the following process fairly successful. The tarsi to be sectioned were fixed in mercuric-chloride-acetic-acid or picro-chlor-acetic acid. They were then well washed in 70% alcohol and transferred to anhydrous ether applied with two changes of about an hour each. The tip of the fifth tarsal joint was always cut off to allow of the penetration of the fluids.

A weak solution of celloidin was prepared by diluting the thick stock solution with absolute alcohol and ether in the proportions of one to three. The material was immersed in this solution in a test tube and the spirit allowed to evaporate at room temperature shaking up the fluid two or three times a day. The celloidin solution may become thick enough to pour into the mould in four to five days. The celloidin containing the material is then hardened in the mould by contact with chloroform vapour, the blocks trimmed and dropped into a saturated solution of paraffin (52° C.) in chloroform. When the blocks become quite clear, and sink in this solution, they are transferred to melted paraffin, which must not be hotter than its melting point, and the air-pump is applied. This rapidly removes the surplus chloroform. The object is to avoid any prolonged application of heat. The blocks are then placed in watch glasses of melted paraffin kept just at melting point, and should be ready for cooling and solidifying in about 15 to 20 minutes. Sections were made on the rocking microtome. Staining methods used were Cajal's silver-nitrate impregnation after cobalt-nitrate fixation in a vacuum, Mann's methyl-blue-eosin, iron haematoxylin, and saffranin and light green.

No one method of staining showed all that was required. Cajal's formula gave some very beautiful preparations showing the terminal nerve filament traversing the chemoreceptor hair. Haematoxylin was disappointing, giving, unusually, a poor definition of the cells. Perhaps the best single preparation secured was one stained with Mann's methyl-blue-eosin.

Plate III, fig. 1, is an accurate drawing of a longitudinal section of the fourth, third, second, and most of the first tarsal joints of the hind-leg of a male *Pyrameis atalanta*. It was made with the aid of a vertical micro-projector apparatus.

Before referring to the sense-organs it seems desirable to mention the structure, of which a small part is shown in section at TG. It may be temporarily described as the tendon-gland. I have been unable to find any published description of it, though it seems very unlikely that it has not been observed. There are no muscles in the tarsal joints, but the tubular tendon passes right through to the extremity of the fifth. In the first it becomes slightly expanded, and is packed round with a mass of large and heavily nucleated cells, the function of which I am unable to suggest. The section from which the drawing was made has just touched the tendon in the first tarsal joint.

Tarsal Spines.—The large tarsal spines TS, with which the tarsi are plentifully beset, do not present any features of unusual interest. There is a large modified hypodermal cell associated with each spine, though not being always in the same plane with the spine itself, it is not invariably evident in all sections. I take this large cell to be a trichogene. The spines are stout and ribbed and their sockets of the usual type. They may be supposed to have tactile sensitivity, though so far I have been unable with certainty to make out any definite nerve connection. If, as seems probable, there is such an innervation it is likely to arise from a single sensory cell with an extremely delicate distal process. In some preparations there are small hypodermic cells any one of which might be modified into a sensory cell, but its identification as such has not yet been possible. There is no sign of any continuation of a nerve process into the

interior of the spine, and if present it probably terminates, as usual, on the margin of the socket. There is thus no evidence that the large spines are chemoreceptors, and in view of their heavy structure we should not expect any such function in connection with them.

Chemoreceptors.—There are, however, especially, though not invariably, near the joints, certain other organs having a much more elaborate innervation. They consist of extremely slender thin-walled tubes, fig. 1, CR. They are set in sockets of the usual kind, but are supplied with several modified hypodermal cells. The cells usually associated with such organs are a trichogenic, a cap-cell, and several sensory cells, the latter having distal processes in the form of a fasciculus, terminating in a thread, doubtless made up of several fibres.

Fig. 2 is a partly reconstructed drawing showing two spines and one chemoreceptor, CR. The latter, in the section from which it was taken, shows a bundle of associated cells, but these are not well differentiated. The large cells, TC, at the bases of the spines are probably trichogenic, and as already noted, special sense-cells are not evident. A small branch of the crural nerve is seen at N.

Fig. 3 is a very highly magnified view of another example of a chemoreceptor. Here there is one very large cell, TC, which is probably the trichogene, a bundle of cells, SC, almost certainly the sensory cells, and a less distinct mass, CC, which is perhaps the cap-cell, if such be present. The most interesting feature of the organ is the terminal thread of the sense-cells, which enters the delicate tube T on the edge of its base, and taking a somewhat irregular course, extends right to the distal end, where there is a minute papilla, P. This, and a small area, A, at the end of the tube, stain darkly by the Cajal process, and sometimes with haematoxylin.

I have no doubt that these organs are the chemoreceptors of the tarsi. They are on the underside in the natural position of the foot, and there are no other structures present to which such a function could be attributed. So far as the presence of these organs is concerned there does not appear to be any marked difference between the middle and hind feet, nor between the sexes.

Examination of many sections shows that the whole tarsus, especially at its distal extremity, is highly innervated, the main nerve giving off many small branches, apparently more numerous than the spines and chemoreceptors. Probably its whole under-surface is highly sensitive to tactile stimuli, and the very minute papillae present on the chitin may themselves be innervated, though of this I cannot at present be certain. The ordinary hypoderm, H (fig. 1), of the tarsus is poorly differentiated, but in transverse section appears somewhat thicker on the ventral than on the dorsal side. There are large tracheal spaces, TrS, often surrounded by a granular substance, G, resembling blood particles. The dorsal surface of the tarsus is clothed with ordinary scales, S.

It is interesting to note that the chemoreceptive organs I have described are not necessarily correlated with food reception, since they are present in *S. carpini*, a species which does not feed in the imaginal state. It is true, however, that in this species I have been unable to make out so complete an equipment of special cells, and the organs may be partly degenerated, also there are very few in the male tarsus. It is even more interesting to find that similar organs, well developed, are found on the partially aborted front feet of *Pyrameis cardui* ♀ and doubtless of other Nymphalid species, showing that though these legs are reduced in size they still have sensory functions. No trace of anything of the kind can be found in the brush-like feet of the males.

I have to thank Professor Minnich for his ready and courteous assistance and for sending me some preserved material from America, though I regret I was not successful in making sections from it.

References.

Minnich, D. E. 1921, An Experimental Study of the Tarsal Chemoreceptors of two Nymphalid Butterflies. J. Exp. Zool., **33 :** 173–203.

Further experiments by the same Author in

1922, J. Exp. Zool., **35 :** 57–81.

loc. cit., **35 :** 445–457.

1926, Biol. Bull., **51 :** 166–178.

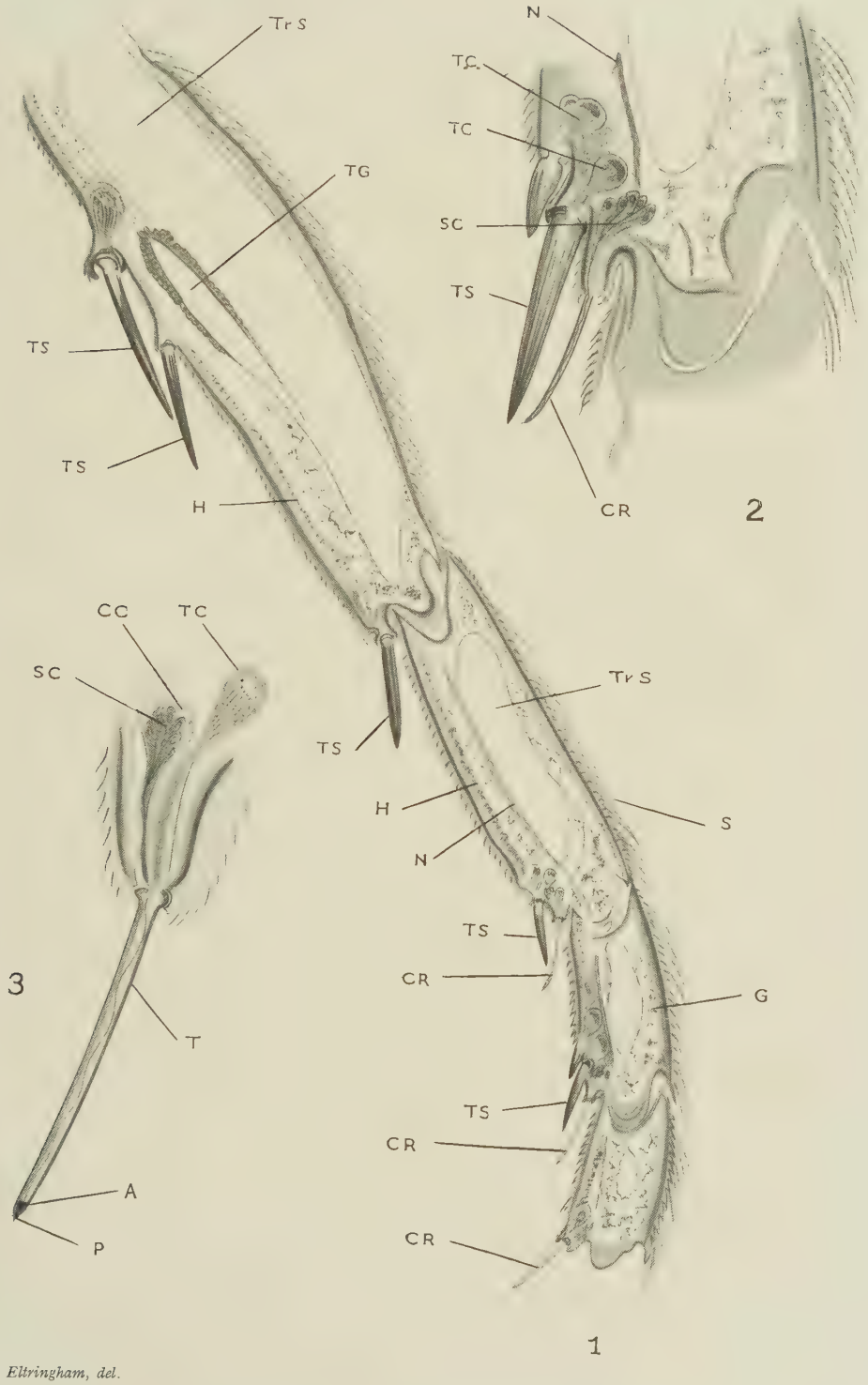
1929, Z. vergl. Physiol., **11 :** 1–55.

Explanation of Plate III.

Fig. 1. Longitudinal section through 4th, 3rd, 2nd, and part of 1st tarsal joint of hind-leg of *Pyrameis atalanta* ♂. TrS, Tracheal space. TG, Tendon gland. TS, Tactile spine. H, Hypoderm. S, Scales. CR, chemoreceptor. G, Blood particles. N, Nerve.

2. Portion of a similar section more highly magnified, and partly reconstructed. N, Nerve. TC, Trichogenic cells. TS, Tactile spine. CR. Chemoreceptor. SC, Sensory cells.

3. A Chemoreceptor very highly magnified, and partly re-constructed. TC, Trichogenic cell. CC, probable Cap-cell. SC, Sensory cells. T, Tube of Chemoreceptor. A, Dark-staining end of tube. P, Papilla.
   Diameter of Chemoreceptor Tube, ·062 mm.
   Length of ditto, ·15 mm.



H. Eltringham, del.

Sense organs in Lepidopterous Tarsi.

STUDIES ON ETHIOPIAN SIMULIIDAE. *SIMULIUM DAMNOSUM*, THEO.

By E. G. Gibbins.

[Read December 7th, 1932.]

With Plate IV and Twenty-seven Text-figures.

Simulium damnosum * is one of the most troublesome biting insects of certain parts of Tropical Africa. The earliest reference to what was undoubtedly this fly is made by Speke (1863), who, in describing his discovery of the source of the River Nile, says: "A small black fly, with thick shoulders and bullet-head infests the place, and torments the naked arms and legs of the people with its sharp stings to an extent that must render life miserable to them." It was not, however, until many years later that specimens of this vicious insect were captured and sent to England for determination. The species was first described by Theobald (1903) from female examples collected by the late Dr. Cuthbert Christy on the right bank of the River Nile near Jinja (a town situated at its source). Nevertheless there still remains considerable doubt as to the true identity of the male and early stages. Pomeroy (1920) figured as *damnosum* the terminalia of a male *Simulium* and the respiratory filaments of a pupa from material collected at Morogoro in Tanganyika, and Bequaert (1930) attributes a larva and pupa found breeding at Gbanga in Liberia to this species; the descriptions and illustrations of both authors differ and neither agree with the writer's material collected from the type locality in Uganda.

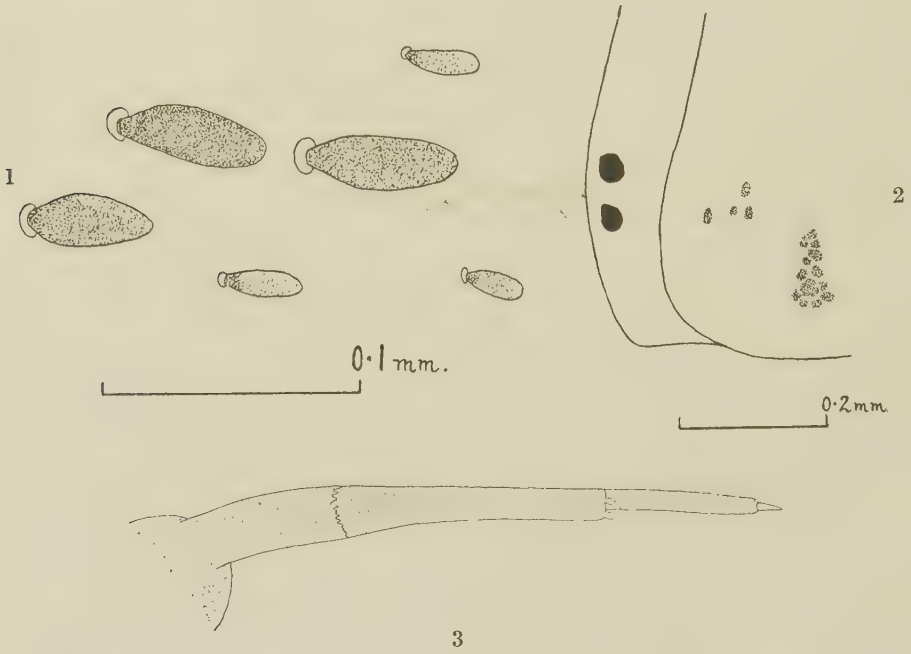
Dr. F. W. Edwards has kindly compared the specimens from the type locality with those in the collection of the British Museum, described by Pomeroy from Morogoro and Amani in Tanganyika. He informs me that he does not see much difference in the male genitalia and that Pomeroy's figures were prepared from specimens which had been dissected, the individual parts flattened as much as possible, and drawn separately, the drawings then being placed together into a composite whole. This gives a very different and distorted appearance as compared with a whole undissected hypopygium, with the parts in their natural relative positions. He tells me that Pomeroy's female *damnosum* seem to be quite similar to those from the type locality, but that there is a striking difference in the thoracic markings of the males; those from Uganda having the silver-grey shoulder marks connected with the silvery posterior border, while Pomeroy's resemble many European species in having separate silvery marks on the shoulders. The writer considers that the differences are sufficient to indicate that Pomeroy's specimens are at least racially distinct from *damnosum*.

In view of the existing uncertainty regarding the true identity of the male and early stages and the very brief published account of the female, it is proposed in the present paper, in order to avoid further confusion, to describe

* *Simulium damnosum* is known to the native as *mbwa* in Luganda and Lutoro; the word translated into English signifies a dog and refers to the ferocity of the bite of the insect.

all the available phases of this important insect. A short account of the bionomics of the species is also given.

The female *damnosum* is redescribed from adults which were reared from isolated pupae and which were identical in external characters and terminalia with specimens captured in the act of biting man in the vicinity of the type locality near Jinja. The male is described from examples bred from isolated pupae collected at the same time and removed from the same material as those from which the females emerged. The respiratory filaments of the pupal pelts from which the two sexes had emerged, after being dissected off and mounted, were subjected to careful microscopical examination and proved indistinguishable. The larva is described from mature mounted specimens which were



Figs. 1–3.—Larva. (1) Spatulate scales; (2) Part of head showing spots on the front; (3) Antenna.

correlated by dissecting out the nymphal respiratory organ and comparing it with the above preparations.

The nomenclature employed throughout this paper is that of Patton and Evans (1929) with the exception of the terminalia for which the terminology of Puri (1932) is used.

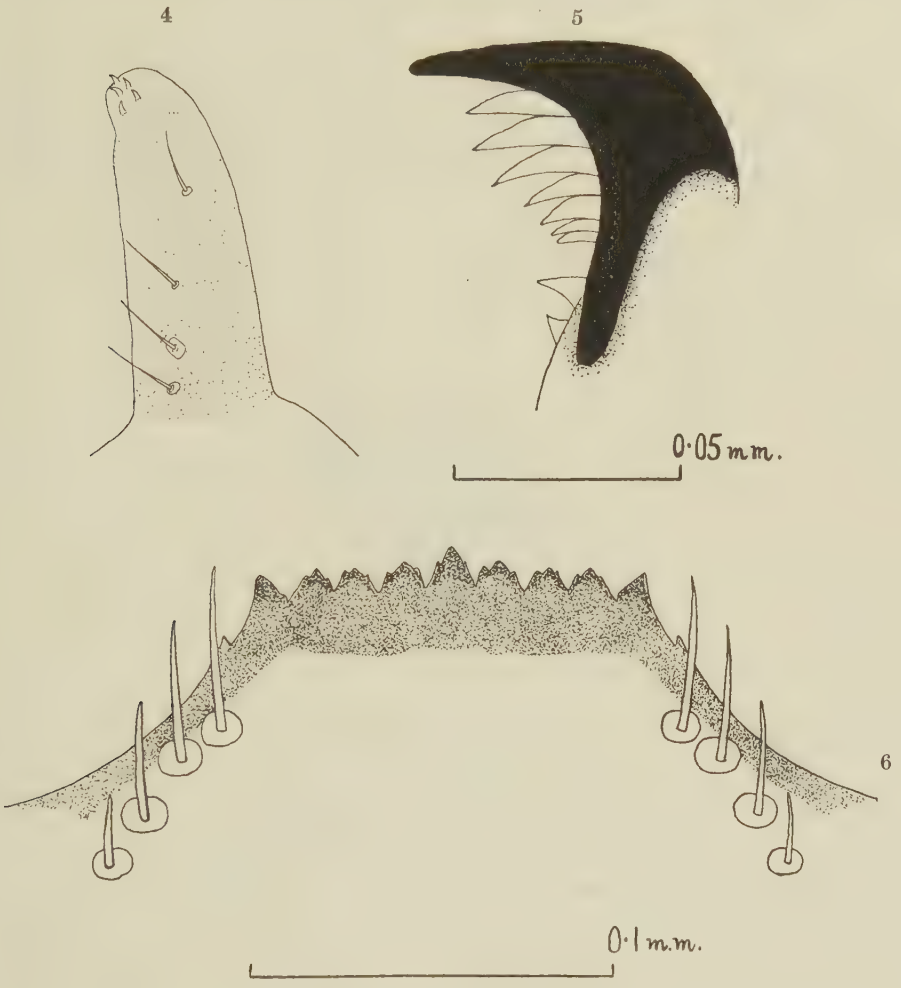
Description.

Larva.

Length 4·8–5 mm. General colour light brown, body peppered with spatulate scales varying much in size and in the degree of chitinisation (figs. 1–3).

Head. Front with a median group of about 13 spots arranged in a triangle and four separate spots situated a little above the median group and near the margin (fig. 2). Antenna (fig. 3) short, consisting of four segments, the whole slightly longer than the base

of the feeding brushes; the second segment twice as long as the first and bearing at its distal end two knob-shaped sensory processes, third about as long as the first, fourth consisting of a small unchitinised cone. Palps (fig. 4) crowned with small curved teeth and bearing laterally four stout bristles arranged obliquely at irregular intervals. Mandibles (fig. 5) with a main strongly chitinised bill-hook-shaped tooth and with nine smaller teeth



Figs. 4–6.—Larva. (4) Palp, lateral view; (5) Mandible, lateral view (figs. 3–5 same magnification); (6) Mentum.

progressively increasing in size distally and protruding from its concave surface. Mentum (fig. 6) with a terminal row of nine heavily chitinised teeth, the median slightly longer than the rest, and all excepting the outer bluntly trifid; on each side a single tooth projects laterally, and a row of stout spines which arise from clearly defined bases lies obliquely near the inside edge of the heavily chitinised margin. Feeding brushes with 19–24 bristles.

Thorax. Thoracic patch (fig. 7) irregularly oval and wrinkled; in cleared specimens

a single semi-transparent filament encircling a dark area on either side in which four filaments are indistinctly visible can be made out. Thoracic pseudopod short and about twice as long as its maximum width.

Abdomen. Anal gills (fig. 8) with secondary finger-like processes, the median lobe divided into nine and the lateral into twelve. Anal armature as in figure 9. Anal sucker with 130 rows each containing 25–30 hooks.

Pupa.

The respiratory organ (fig. 10) is pale and translucent. It is composed of one main broad semicircular tube which lies along the outer edge of the pupa and in contact with the cocoon. From near the centre arise six cylindrical lobes of which three arise dorsally and are arranged vertically touching the inside of the cocoon while the other three are

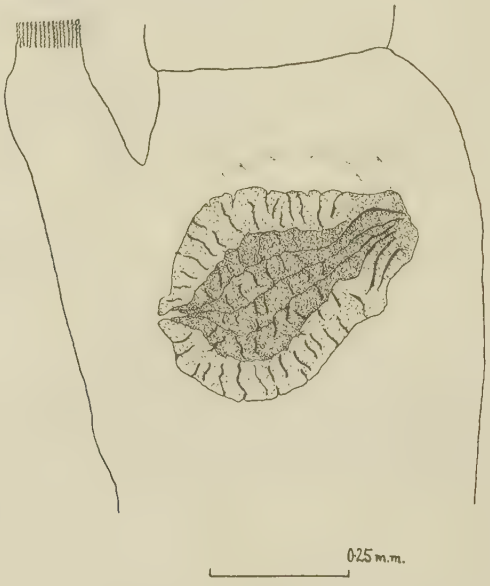


Fig. 7.—Larva. Thoracic patch and pseudopod.

situated ventrally and rest upon the upper surface of the pupa. These have short secondary finger-like processes which originate about the centre and in their natural position sway with the motion of the water. The cocoon (fig. 11) is a finely woven slipper-shaped structure, 4 mm. long.

It is somewhat surprising that the pupa of *damnosum* should be provided with an exceedingly fragile respiratory organ when the species is subjected to such violence during this stage of its early life. To some extent this inadequacy had been overcome by the provision of a strong cocoon within the walls of which the pupa sits snugly with its delicate respiratory appendages well inside until the adult is due to emerge (fig. 11). It was this unique habit that enabled the writer to separate specimens of the pupa with comparative ease in the field, by the aid of a small hand lens, from those of other closely allied species. In spite of the protection provided by the cocoon, the lobes were never found intact and always showed some signs of rupture of the chitin.

Female.

Redescribed from 35 specimens bred from the pupa. Specimens captured in the act of biting man nearly always showed considerable loss of scales. The females caught near the River Mubuku were smaller than those from the type locality near Jinja and measured 2·5 mm., whereas the latter were 3 mm., in length; the external characters and terminalia of both forms were identical.

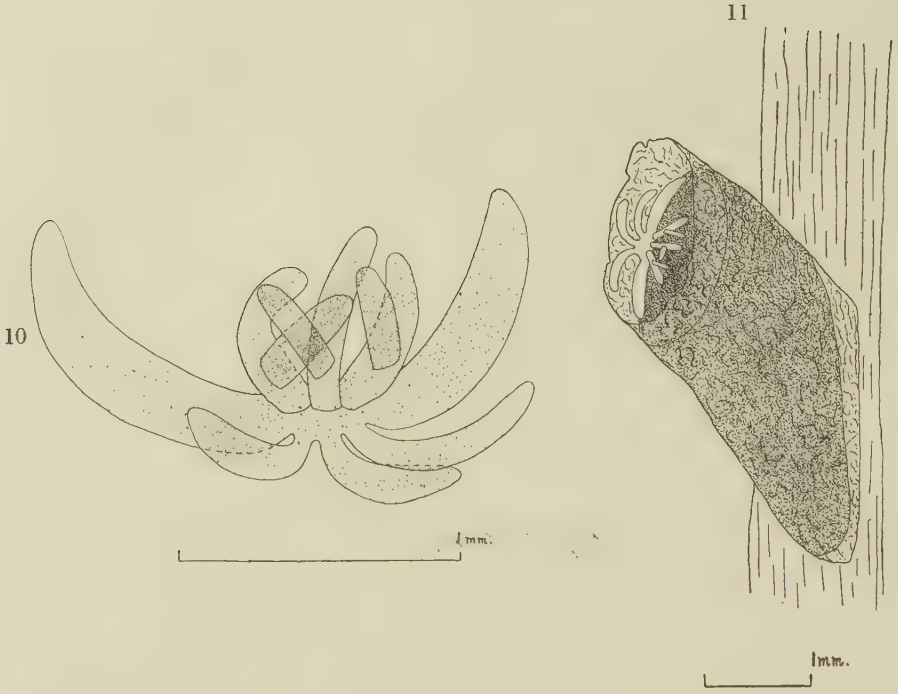
8

9

FIGS. 8, 9.—Larva. (8) Anal gills, median lobe left, lateral lobe right; (9) Anal armature.

Head. Vertex and front dull light grey; the vertex narrows slightly above the antennae and is edged with fine yellow hairs, on the front the hairs are arranged in the form of a fringe. Antennae (fig. 12) dark brown and covered with an ash-grey pubescence, with the exception of the scape and basal segment which are ochraceous.

Thorax lustrous slate-grey. Mesonotum with closely applied, brassy scales, disposed rather thickly laterally and intermingled with black scales dorsally. Scutellum with brassy marginal scales, slightly longer than those of the mesonotum. Pleura without a patch of soft hairs on the membrane behind the thoracic spiracle.



Figs. 10, 11.—Pupa. (10) Respiratory filaments; (11) Cocoon attached to grass stem with pupa inside showing position of the respiratory filaments.

Abdomen. First segment dark brown and fringed with golden hairs, second black with pale yellow scales, third and fourth black with black scales on the dorsal surface and a dense patch of golden scales (fig. 13) laterally; the remaining segments have a metallic lustre and are sparsely covered with fine yellow hairs. Spermatheca (fig. 14) barrel-shaped and heavily chitinised, duct unchitinised.

Terminalia (fig. 15). The anterior gonopophyses each terminate medially in a triangular process bare of setae and ending in a spatulate tip; the processes of the two sides lie one above the other. The cerci are almost rectangular in shape, heavily chitinised and armed

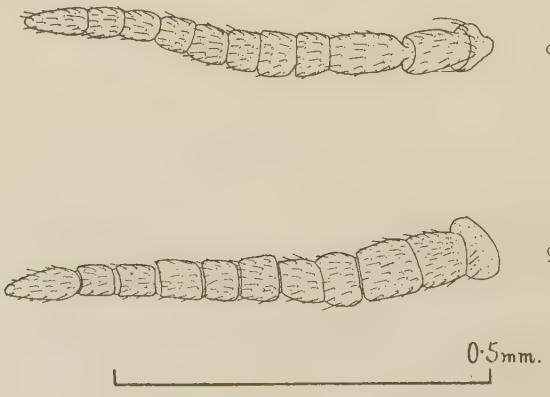
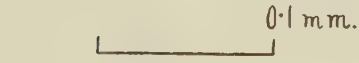


Fig. 12.—Adult. Antennae, ♀ left, ♂ right.

with stout setae, and are attached to the paraprocts on their concave dorsal surface. The tenth tergite is large and lightly chitinised.

Legs dark brown. Coxae and trochanters with pale yellow scales. Front femora with a few yellow scales at the base, tibiae silver-grey on the outer aspect with dark bases and apices, tarsi distinctly flattened (fig. 16). Middle legs sparsely sprinkled with pale yellow scales. Hind tibiae swollen sub-apically and with yellowish pubescence basally; first tarsal segment with a broad median band of silver-grey, pedisulcus well marked (fig. 17).

13



14

Figs. 13, 14.—Adult. (13) Lateral scales of ♀ abdomen; (14) Spermatheca.

Claws (fig. 18) with well-developed basal projection. Wings (fig. 19), base of radius with dark hairs.

Male.

Length 3·2 mm.

Head. Vertex and front dark grey, the former bare of setae and the latter covered with long dark hairs. The antennae (fig. 12), excepting the scape which is light brown, are dark with grey pubescence.

Thorax lustrous slate-grey with a striking velvet-black pattern consisting of a wedge-shaped stripe and a lateral convexo-convex patch on either side (fig. 20) sparsely covered with black scales. The integument is adorned with brassy scales anteriorly and laterally,

and black scales medially. Scutellum velvet-black with long dark hairs intermingled with brassy scales.

Abdomen velvet-black with long hairs; second segment slate-blue with a black median apical patch clothed with black scales, fourth and fifth with a conspicuous slate-blue shield-shaped patch on the lateral surface.

Terminalia (fig. 21). Intercoxal piece anchor-shaped and heavily chitinised. Coxites broad with a narrow tapering lateral process which continues round two-thirds of the style and carries a long slender hair at the tip. The styles are relatively short and inwardly concave; rather broad at the base they narrow suddenly in the anterior third and end

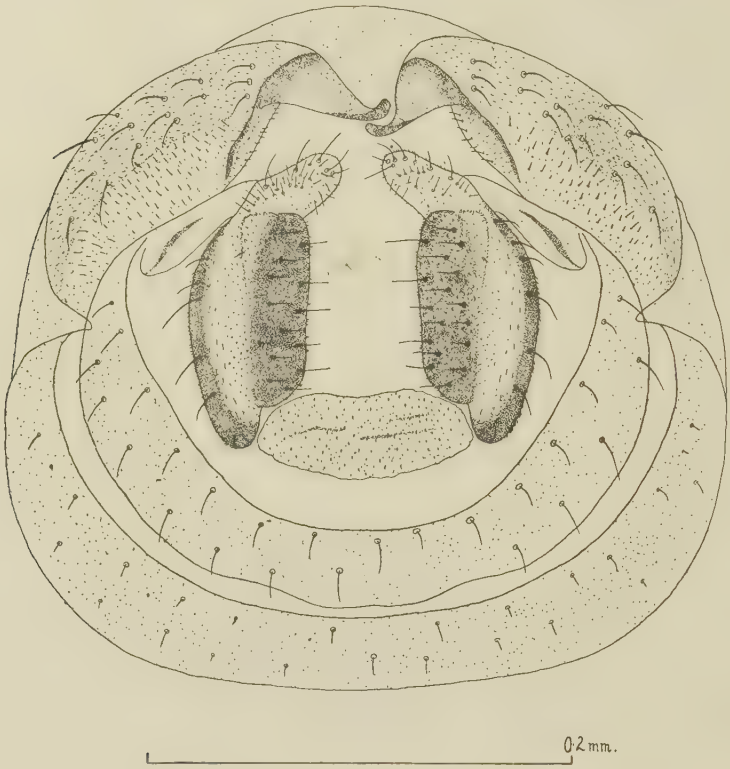


Fig. 15.—Adult. Female terminalia, posterior view.

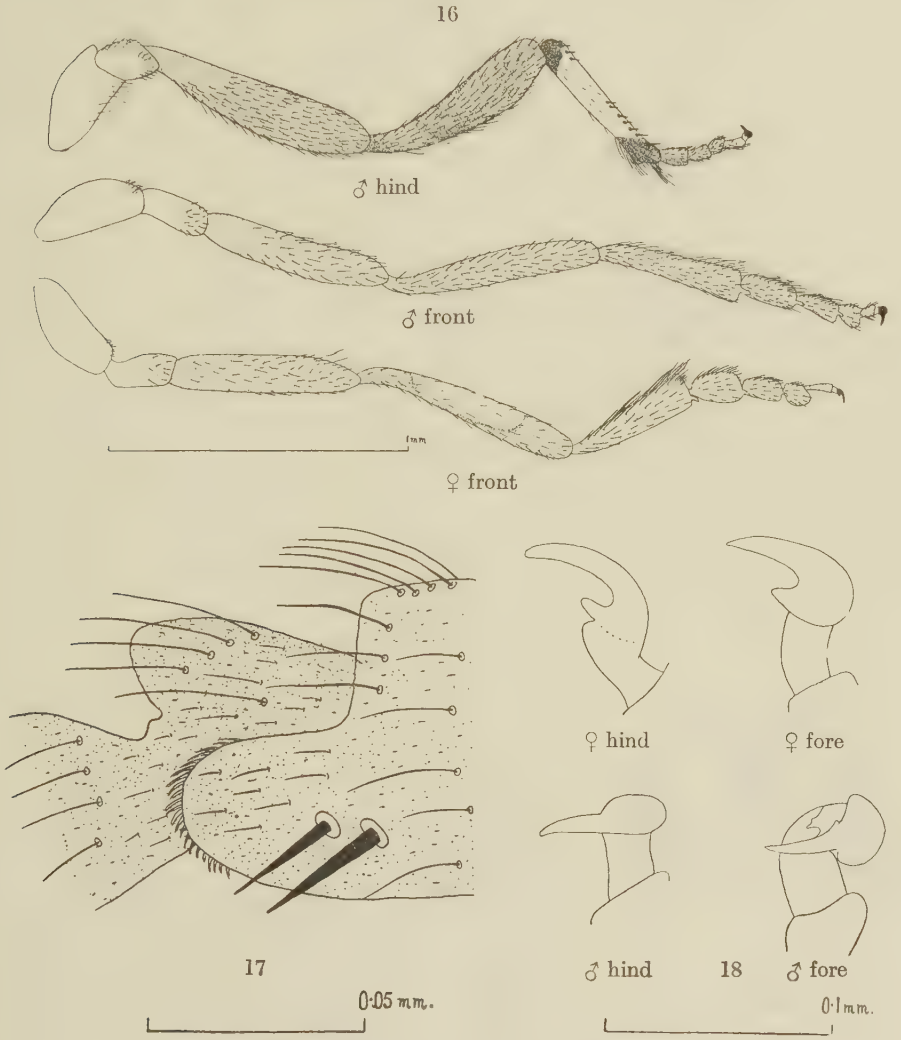
in a blunt point, on the dorsal surface a short distance from the tip is a prominent thumb-like projection which lies close alongside to the distal end. Cerci and tenth tergite as shown in fig. 21.

Legs (fig. 16) dark brown. Coxae and trochanters with yellow hairs. Front femora sprinkled with yellow scales, tibiae outwardly silver-grey with base and apex dark. Mid femora sparsely sprinkled with yellow scales. Hind tibiae swollen sub-apically and with yellow scales basally, first tarsal segment with a broad median band of silver-grey, pedisulcus well marked. The claws (fig. 18) of the fore legs are peculiar, hobnail-shaped with a small basal notch supplemented by a secondary, less chitinised tooth-like process and fixed to a recurved basal segment. Wings as in the female.

Uganda: Jinja, 6 ♂♂, 4.iii.32, 10 ♂♂, 18.v.32.
Bred from pupae.

Mouth-parts of both Sexes.

Palps (fig. 22) shorter in the male than in the female and with a smaller sensory spot. Maxillae (fig. 23) slender in the male and with a few terminal bristles and fine hairs arranged obliquely; broad in the female with strong recurved teeth. The labium (fig. 24) is similar



FIGS. 16–18.—Adult. (16) Legs; (17) Apex of 1st tarsal segment and base of 2nd of the female showing pedisulcus; (18) Claws.

in both sexes; it is squat, fleshy, and finely spiculate with long stout hairs and short spines along its anterior inner margin. The male and female mandibles differ greatly (fig. 25). In the male they are small and pointed; in the female they are large and broad anteriorly with closely set short teeth. The hypopharynx (fig. 26) of the male is narrow and conical with a rounded end bearing short bristles and a line of fine hairs in the lightly chitinised sub-median anterior areas; in the female it is broad and almost the same width basally as

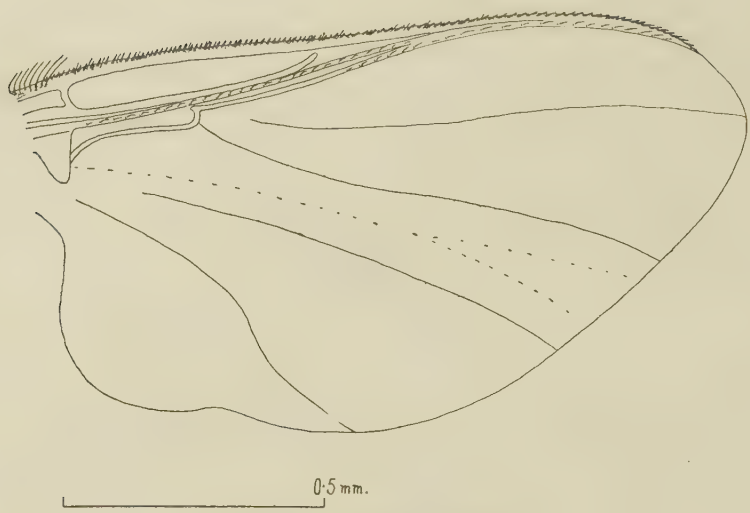
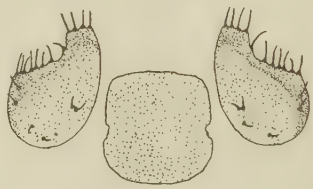
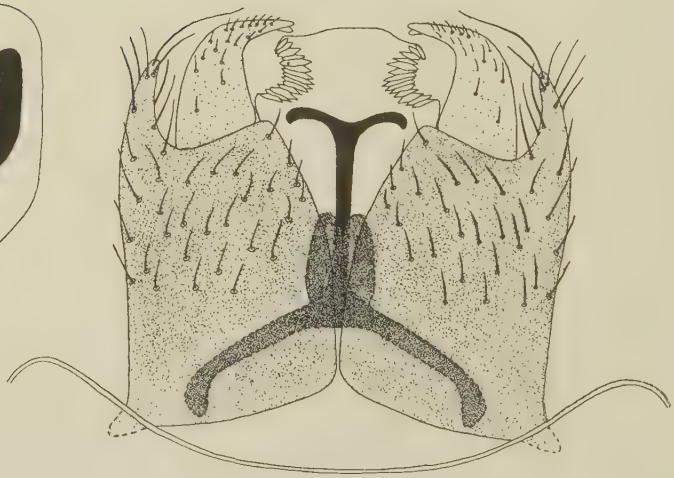


Fig. 19.—Adult. Wing ♀.

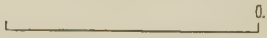
anteriorly, the sides are slightly hollowed, and the anterior end is semicircular with attenuated teeth. The chitinised plate situated at the end of the labrum-epipharynx of



20



21

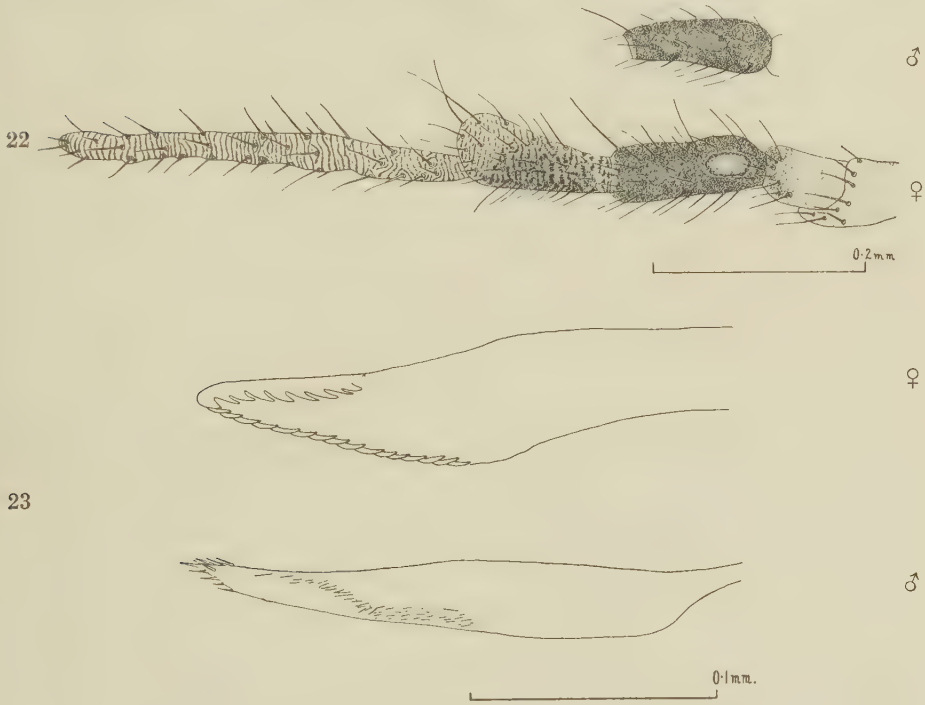


Figs. 20, 21.—Adult. (20) Thorax of male showing velvet-black pattern (partly diagrammatic); (21) Male terminalia.

the female (fig. 27) is armed with a pair of strong hooks each with three recurved teeth, while in the male (fig. 27) the plate is modified and the hooks are entirely absent.

Biology.

The region of the type locality near Jinja was visited on two occasions for the purpose of studying the biology of *Simulium damnosum*. The first visit was made in February 1932, during the dry season when the River Nile was low, and coincided with a period of great female density-activity; the second visit was undertaken in May, three months later, during the rains when the river



Figs. 22, 23.—Mouth-parts of both sexes. (22) Palps of ♀, and 3rd segment of ♂ showing sensory spot; (23) Maxillae ♂ left, ♀ right.

showed a considerable rise, and was accompanied by a marked diminution in adult prevalence.

Breeding-places.

The collection of material for examination from places likely to yield *S. damnosum* was rendered extremely difficult owing to the presence of crocodiles and the particularly strong current. It was impracticable to explore the river-bed in other than one small area, and it was only possible to examine the luxuriant pendulous grasses from two rocky islets.

An examination of the submerged vegetation and rock in the river and in the lake near its source revealed the fact that it is only in the most highly aerated parts that *damnosum* breeds. In swiftly flowing but only moderately aerated water *Simulium* larvae and pupae of two undescribed species, which will be

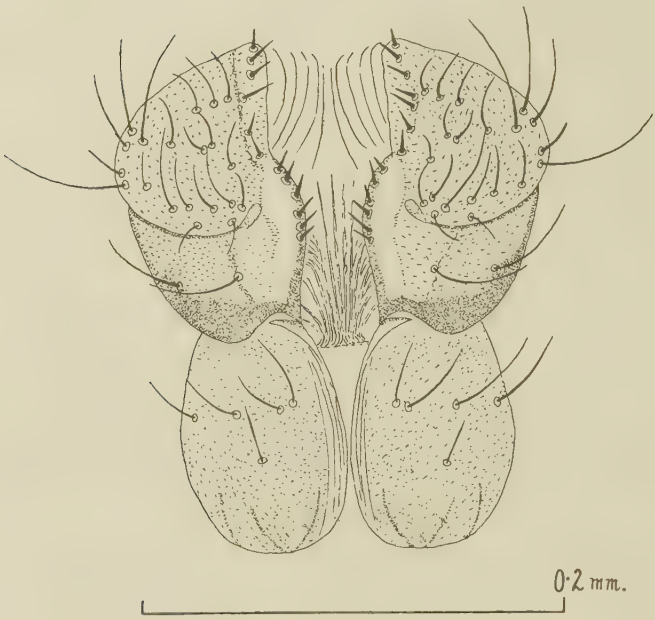


Fig. 24.—Mouth-parts of both sexes. Labium.

dealt with in a later paper, occurred in profusion but only on one occasion was *S. damnosum* found amongst them in this particular type of habitat. In this instance a single pupa was found which, as a larva, may have lost its hold in the more turbulent waters and managed to anchor lower down the river.

The larvae and pupae of *S. damnosum* were found in small numbers intermingled with an abundance of another species of *Simulium* attached to the blades and stems of long quivering grasses dipping into the most agitated water

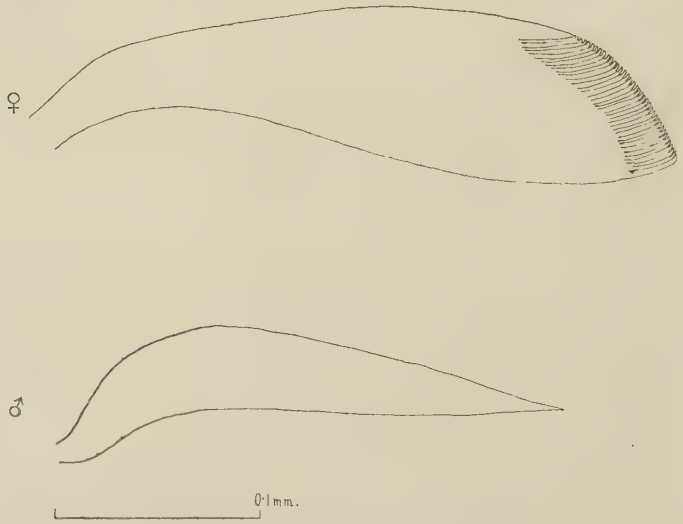


Fig. 25.—Mouth-parts of both sexes. Mandibles ♀ left, ♂ right.

of a Nile rapid, and on the clean face of loose rough rocks lying on the river bed in extremely effervescent water about 2′ 6″ deep. None of the grasses hanging in the rapids from the river bank furnished examples of *S. damnosum*, but those having peculiarly long stems dangling in the turmoil from rocky islets yielded a number of specimens.

Blood-sucking Habits.

The female is active between sunrise and sunset. In the cool of the early morning there are few on the wing, but as the day brightens so they increase

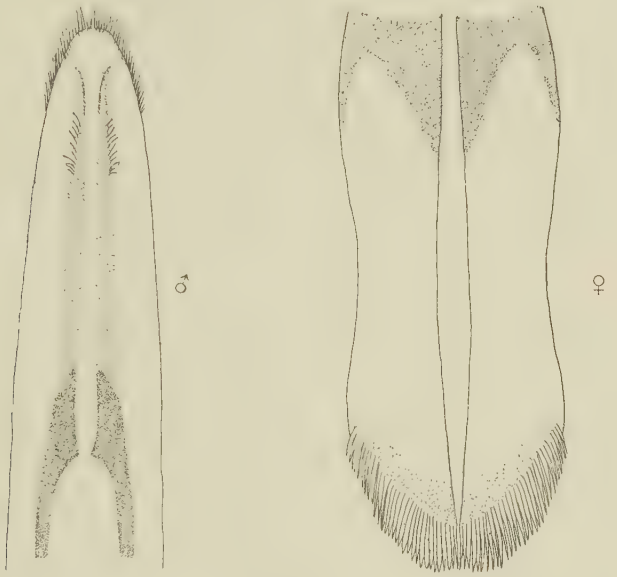


Fig. 26.—Mouth-parts of both sexes. Hypopharynx ♂ & ♀.

until the hour of sunset when a maximum density is reached. On dull days they are not so active as on bright ones, though they are more prevalent in the shade of forest than in open spaces in strong sunlight. Man is apparently a favourite source of food of this insect. The tiny creature will attack any naked part of the body but especially the lower extremities. It is apt to crawl up the arm under the sleeve of a coat or the leg beneath shorts. The naked skin is always chosen in preference to the hairy, but it will bite through thin stockings. Alighting quietly on the skin the fly wanders rapidly around patting the surface with its fore legs and looking for a suitable spot. It then thrusts its head well down, pushes its formidable proboscis in, and commences to feed greedily. On flying away a tiny trickle of blood flows from the bite which ultimately develops into a small, extremely irritating wheal, often persisting for several days. A characteristic red spot formed by congealed blood and left at the site of the puncture appears to be diagnostic of the bite of this insect.

Blacklock (1926) proved a species, determined as *Simulium damnosum*, to be a carrier of *Onchocerca volvulus* in the Konno district of Sierra Leone, and Bequaert (1930) demonstrated the same Nematode in wild flies caught at Gbanga in Liberia.

Seasonal Prevalence.

The fluctuation in the level of the River Nile apparently plays an important rôle in the seasonal prevalence of this insect. The first visit in February coincided with great female density and activity; in the town of Jinja the European inhabitants were being voraciously bitten in their gardens, and the fly was the cause of much annoyance while the writer was engaged in searching breeding-places. At this period the river was low and the early stages were somewhat

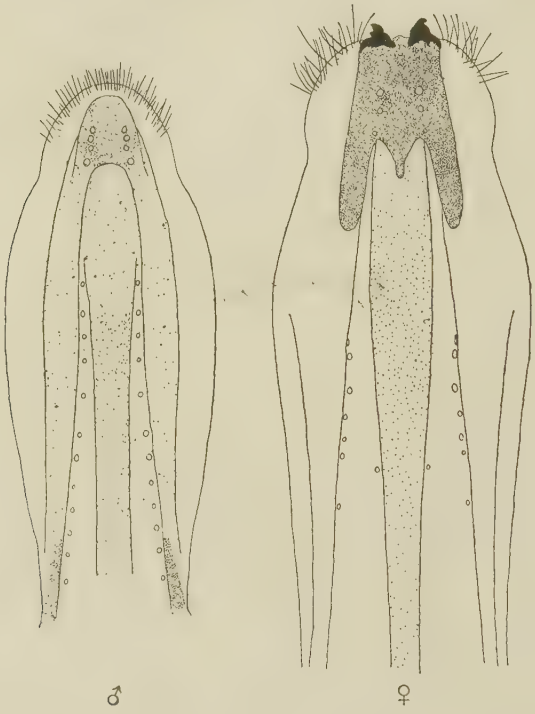


Fig. 27.—Labrum-epipharynx ♂ & ♀ (figs. 25–27 same magnification).

difficult to find, whereas on the second visit in May when the river had risen 33 centimetres at its source and new grassy islets were formed, the larvae and pupae were more common and the adult was reduced to an occasional specimen.

Distribution and Range of Flight.

If the published records of De Meillon (1930) are corroborated by correct determinations of captured specimens, *Simulium damnosum* is widely distributed throughout tropical and sub-tropical Africa. The species is recorded from Gbanga, Liberia; the Gold Coast; Cameroon; the Belgian Congo; Uganda; Abu Hamed, Sudan (King 1909); Morogoro, Tanganyika; Nyasaland; Pretoria, Transvaal; and Weenen, Natal. Little is known of its distribution in Uganda. Specimens of the adult fly were caught in the act of biting man near the River Mubuku in January at an altitude of about 3500 feet; this river, which rises in the glaciers of Mt. Ruwenzori, appeared to be particularly suitable for the aquatic stages of the insect. Simultaneous with the examination of the

River Nile, the River Sezibwa was investigated; coinciding with the great female density-activity in the region of the Nile in February, the species was extremely common in the vicinity of the Sezibwa, while in May it was entirely absent. Since the river, except in one small area, did not look particularly suitable for the early stages, and as careful search at both seasons failed to yield a single larva or pupa of *S. damnosum*, it appears highly probable that the adults came from the Nile, a flight of about 30 miles.

Acknowledgements.

I am pleased to be able to take this opportunity to thank Mr. H. Hargreaves, Government Entomologist, Mr. G. H. E. Hopkins, Entomologist, and Mr. G. L. R. Hancock, Assistant Entomologist, for their criticisms and valuable suggestions made when reading through the manuscript of this paper. For data regarding levels of the River Nile, I am indebted to Mr. C. W. Wishart of the Uganda Public Works Department, who was in charge of the pumping station at its source. I also wish to express my thanks to Dr. J. D. Tothill, Director of Agriculture, who, in view of the great economic importance of this insect in Uganda, has taken much interest in the present investigation, and to Dr. F. W. Edwards for kindly comparing my specimens with those in the collection of the British Museum.

References.

Bequaert, J. 1930, The African Republic of Liberia and the Belgian Congo, **2 :** 851–852.

Blacklock, W. B. 1926, The development of *Onchocerca volvulus* in *Simulium damnosum*. Ann. Trop. Med. Parasit., **20 :** 1.

De Meillon, B. 1930, On the Ethiopian Simuliidae. Bull. Ent. Res., **21 :** 197.

King, H. H. 1909, Third Rept. Welcome Res. Labs., Khartoum, **1908 :** 208.

Patton, W. S., & Evans, A. 1929, Insects, Ticks, Mites and Venomous Animals of Medical and Veterinary Importance.

Pomeroy, A. W. J. 1920, New species of African Simuliidae. Ann. Mag. Nat. Hist., (9) **6 :** 79.

Puri, I. M. 1932, Studies on Indian Simuliidae. Ind. J. Med. Res., **19 :** 884.

Speke, J. H. 1863, A journal of the discovery of the source of the Nile, p. 465.

Explanation of Plate IV.

River Nile near Jinja.

The rocky islets separating the fierce rapids in the centre of the picture are typical of those with luxuriant pendulous grasses from which *Simulium damnosum* was obtained. The small rapid in the foreground is not sufficiently aerated for *S. damnosum*.

Photo. by W. J. Eggeling.

The River Nile near Jinja.

THE PASSALIDAE OF THE BELGIAN CONGO

By W. D. Hincks, M.P.S.

[Read 7th December, 1932.]

With Plate V.

The present paper is not intended as more than a preliminary contribution towards the classification of some African Passalidae. A revision of the whole of the species (though by no means numerous) must await more extensive material and until it has been possible to examine the types of Kuwert.

The material studied, besides that in my own collection, consists of a very fine series of specimens sent for identification by the authorities of the Congo Museum, Tervueren, to whom I wish to express my deep obligation. I wish to acknowledge also my indebtedness to Mr. G. J. Arrow for much assistance and for the loan of specimens from the British Museum collections, to the Director of the Museum of Zoology and Comparative Anatomy, Turin, for the loan of one of the two specimens from which Pangella described *Didymus aloysii sabaudiae*, and to the Director of the Berlin Zoological Museum for the loan of the type of *D. livingstoni*, Kuwert.

Records of material from localities other than the Belgian Congo are reserved for subsequent publication, and as it is hoped, at a later date, to issue a fuller account of the African species detailed descriptions are not here included. Attention is, however, drawn to the taxonomic characters and the species are tabulated.

It has been thought advantageous to give the localities of the material studied in some detail in view of the few authentic records hitherto published. No really adequate idea of the distribution of the African species is yet possible on account of this paucity of full data, and in this connection it may be mentioned that my own specimens are unfortunately frequently much less fully labelled than the beautiful material of the Congo Museum.

The conclusion is inevitably reached that the species are less numerous than has been supposed and that a number of Kuwertian names are of no specific value. Several are here relegated to the status of synonyms, and when the types have been examined, others may be expected to sink; consequently the names here used may possibly require emendment when older ones are recognised. Since the time of Kuwert, the Solenocyclinae have received little attention with the exception of the description of several forms by Zang, Pangella and Arrow. Gravely's excellent paper published in 1918 (*Mem. Ind. Museum*, **7**) deals with the Passalidae of the world and includes tables and notes on ten African species (excluding Malagasy forms) based apparently on somewhat scanty materials.

The Genera.

In discussing the genera of the Solenocyclinae, Gravely (*loc. cit.*, 1918, 7: 69) writes: "I propose to unite under the name of *Pentalobus*, Kaup, all

species with hairy sides to the metasternum and a more or less distinct tubercle or pair of tubercles or excavation in the middle of the anterior margin of the head; and to unite under the name *Erionomus*, Kaup, all species in which the sides of the metasternum are hairless, and the middle of the anterior margin of head is straight."

The characters of the presence or absence of hair on the metasternum should be transposed to accord with the table of genera given by Gravely lower down on the same page where he defines *Pentalobus* as having the sides hairless and *Erionomus* as having them hairy. By this arrangement *P. palini* (Perch.) is excluded from *Pentalobus*. I think, however, that it is more naturally placed with *P. barbatus* (Fab.) which also has hairy lateral areas to the metasternum though the hairiness is much less dense, and this seems to have been overlooked by Gravely. These two species may be separated (as in Kaup's arrangement) from the rest of Gravely's *Pentalobus*, which will take the name of *Didymus* and include the Kuwertian genera *Didymus*, *Eumelosomus* and probably *Didymoides*. Whilst admitting that the characters which separate *Pentalobus* and *Didymus* are perhaps not generic, the division has the advantage of being convenient, easy of application and in accordance with common usage, and it will represent at least a subgeneric section. The following is a table of the genera I recognise excluding the Madagascan forms.

Key to the Genera.

1. Antennal club with five lamellae of which the first may be very short; lateral areas of metasternum may or may not be hairy; much flattened insects. . . . . *Pentalobus*, Kaup.
   Antennal club with only three lamellae . . . . . 2.
2. Sides of elytra, at least basally with hair-bearing punctures; sides of metasternum hairy; anterior margin of head between the outer tubercles more or less straight without definite secondary tubercles; puncturation of elytral grooves almost obsolete; medium to large convex species. *Erionomus*, Kaup.
   Sides of elytra hairless; sides of metasternum hairless;* anterior margin of head between outer tubercles with one or two secondary tubercles or with a median concavity; elytral grooves usually strongly punctured laterally; small to medium species . . . . . *Didymus*, Kaup.

Erionomus, Kaup.

Kaup, 1868, Coleopt. Hefte, **3** : 16; 1871, Berlin. Ent. Z. Suppl., **15** : 27.
Kuwert, 1891, Deuts. Ent. Z., **35** : 176; 1896, Novit. Zool., **3** : 222; *loc. cit.*, 1897, **4**: 137.
Gravely, 1918, Mem. Indian Mus., **7** : 69, 74 (pars.).
Hincks, 1931, Ent. Mon. Mag., **67** : 137.
Eriosternus, Kuwert, *loc. cit.*, 1891, **35** : 183; *loc. cit.*, 1896, **3** : 222; *loc. cit.*, 1897, **4** : 138.

Type : *E. planiceps* (Eschsch.), 1828.

The species of this genus form a compact and easily separable group and I have little to add to my previous paper referred to above.

I have not yet seen specimens of *E. latericrinitus*, Kuw., from Belgian Congo, but the three other species are tabulated below.

* Hairy in those species referred to *Didymoides* of Kuwert. Such species resemble *Erionomus* in general appearance but lack the hairy-sided elytra and have the head of a typical *Didymus*.

Key to the species of Erionomus.

1. Elytral costa not reaching shoulder ; epipleurae not differentiated . . . 2.
   Elytral costa reaching shoulder and cutting off externally a more or less broad epipleural strip. L. 31–35 mm. . . . . *E. pilosus*, Auriv.
2. Outer tubercles directed upwards and failing quite to reach the fore margin of head; hair bearing punctures restricted to about a basal one-fourth of elytra. L. 35–43 mm. . . . . *E. planiceps* (Eschsch.)
   Outer tubercles directed forwards and extending beyond fore margin of head; hair-bearing punctures on sides of elytra more extensive, reaching almost to the middle in typical specimens. L. 31–37 mm.
   E. platypleura, Arrow.

1. *Erionomus planiceps* (Eschsch.).

Eschscholtz, 1829, Nouv. Mem. Mosc., **1** : 22–23. (*Passalus.*)
Percheron, 1841, Mag. Zool., **25**, t. lxxviii, f. 3. (*Passalus.*)
Kaup, 1868, Coleopt. Hefte, **3** : 17; 1871, Berlin. Ent. Z. Suppl., **15** : 27.
Kuwert, 1891, Deuts. Ent. Z., **35** : 176; 1897, Novit. Zool., **4** : 137.
Gravely, 1918, Mem. Indian Mus., **7** : 75, fig. viii, 5, p. 70.
Hincks, 1931, Ent. Mon. Mag., **67** : 129.

The smaller details of puncturation and structure are somewhat variable though the more important are quite constant in the large number of specimens seen from many African localities. This species, which is the largest African form yet known, is at once recognised by the form of the outer tubercles in unworn examples.

Coll. Musée du Congo : 1 ex. Bas-Uele : Bambesa, 1930 (*Liontovitch*); 3 exs. Ituri : Mongbwalu, xi.29 (*Mme. Milliau*); 1 ex. Equateur : Flandria, 1929 (*Hulstaert*); 1 ex. Sankuru : Komi, v.30 (*Ghesquière*); 28 exs. Irumu—Mombasa, 10.x.31 (*Mme. L. Lebrun*).

Coll. Hincks : 2 exs. Medje (via *Staudinger*); 15 exs. Buta (via *Staudinger*); 3 exs. Belgian Congo (via *Staudinger*); 2 exs. Entre Lacs Kivu et Edmond (via *Clermont*).

2. *Erionomus platypleura*, Arrow.

Arrow, 1906 (1907), Trans. Ent. Soc. Lond., **1906** : 461.
Hincks, 1931, Ent. Mon. Mag., **67** : 129.

This species has the outer tubercles of normal form and the hairy sides of the elytra much more extensive than in *E. planiceps*; in typical specimens it extends nearly to the middle of the elytra. The two examples before me from Belgian Congo are 31 mm. long and represent the form described by me as *platypleura* var. (*loc. cit.*, 1931, **67** : 129). The differences mentioned in the above referred to paper are perhaps not constant, but with such scanty material as I have up to now been able to examine it is premature to say. It may be mentioned, however, that I have not yet seen any typical *E. platypleura* from West Africa.

Coll. Musée du Congo : 1 ex. Sankuru : Komi (Lodja), iii.30 (*Ghesquière*).

Coll. Hincks : 1 ex. Entre Lacs Kivu et Edmond (via *Clermont*).

3. *Erionomus pilosus*, Auriv.

Aurivillius, 1886, K. Svenska Vet.-Akad. Handl., **12** : 14.
Kuwert, 1891, Deuts. Ent. Z., **35** : 183; 1897, Novit. Zool., **4** : 138. (*Eriosternus.*)
Hincks, 1931, Ent. Mon. Mag., **67** : 128.
alterego, Kuwert, *loc. cit.*, 1897, **4** : 138. (*Eriosternus.*)
Gravely, 1918, Mem. Indian Mus., **7** : 75.
studti, Kuwert, 1890, Deuts. Ent. Z., **34** : 103–104; *loc. cit.*, 1891, **35** : 176; *loc. cit.*, 1897, **4** : 137.

In neither of the foregoing species does the costa of the elytra reach the

shoulders, a character which will separate them from the present in which a clearly defined epipleural strip is observable. This useful character was first pointed out by Arrow (1907, *Trans. Ent. Soc. Lond.*, **1906 :** 460). *E. pilosus* is evidently a common species in Belgian Congo judging by the number of specimens examined. As pointed out elsewhere (*loc. cit.*, 1931, **67 :** 127) I am unable to consider *E. alterego* (Kuw.) and *E. studti*, Kuw., as distinct.

Coll. Musée du Congo : 3 exs. Bas-Uele : Buta, 1930 (*Fr. Joseph*); 1 ex. Buta (*S. M. Reine Elisabeth*); 18 exs. Lukolela, 4.ii.29 (*H. J. Bredo*); 1 ex. Eala, 19–29.x.29 (*H. J. Bredo*); 16 exs. Eala, 2–4.x.1931 (*H. J. Bredo*); 1 ex. Stanleyville, iv.30 (*J. P. Colin*); 4 exs. Equateur : Flandria, 1929 (*R. P. Hulstaert*); 1 ex. Bumba, iii.31 (*Mme. Babilon*); 21 exs. Lulua : Kapanga, v.1931 (*F. G. Overlaet*).

Coll. Hincks : 2 exs. Belg. Congo (via *Staudinger*); 1 ex. Lukombe, 19.x.08 (*A. Koller*).

Pentalobus, Kaup.

Kaup, 1868, Coleopt. Hefte, **3 :** 17; 1871, Berlin. Ent. Z., Suppl., **15 :** 34.
Kuwert, 1891, Deuts. Ent. Z., **35 :** 191; 1896, Novit. Zool., **3 :** 228; *loc. cit.*, 1898, **5 :** 312.
Gravely, 1918, Mem. Indian Mus., **7 :** 69, 72 (pars.).
Epeus, Kuwert, *loc. cit.*, 1898, **5 :** 278.
Erionomus, Gravely, *loc. cit.*, 1918, **7 :** 69, 74 (pars.).

Type : *P. barbatus* (Fab.), 1801.

The antennae of *P. palini* (Perch.) are usually described as having a four-lamellate club. It can, however, be regarded as having five leaflets of which the first is very short. Kuwert separated several forms from the common and variable *P. barbatus* (Fab.), but the examination of many specimens seems to me to preclude the possibility of their being specifically distinct. *P. savagei* (Perch.) would appear to have been regarded by Gravely as a synonym of *barbatus*. He says (*loc. cit.*, p. 73) that he is unable to find any structural difference between larger specimens of the latter 23–29 mm. long and specimens of from 17–20 mm.

Key to Species of Pentalobus.

1. First lamella of antennal club very short; lateral areas of metasternum strongly hairy; lateral grooves of elytra not very transversely punctured; last abdominal sternite without a tuft of hairs. L. 33–41 mm.
P. palini (Perch.).

   Club of antennae clearly five lamellate; lateral grooves of elytra very transversely punctured; last abdominal sternite with a strong tuft of hairs. L. 15–32 mm. . . . . 2.

2. Lateral areas of metasternum more or less distinctly hairy (in good specimens); anterior intermediate areas and shoulders of elytra hairy; larger form. L. 22–32 mm. . . . . *P. barbatus* (Fab.).

   Lateral areas of metasternum hairless; anterior intermediate areas and shoulders at most very scantily hairy; smaller form. L. 15–21 mm.
var. *savagei* (Perch.).

Pentalobus palini (Perch.).

Percheron, 1844, Mag. Zool., 8–9, pl. cxxxv, f. 1. (*Passalus.*)
Burmeister, 1847, Handb. Entom., **5 :** 475. (*Passalus.*)
Kaup, 1868, Coleopt. Hefte, **3 :** 18; 1871, Berlin. Ent. Z., Suppl., **15 :** 35.
Kuwert, 1891, Deuts. Ent. Z., **35 :** 191; 1898, Novit. Zool., **5 :** 311. (*Epeus.*)
Gravely, 1918, Mem. Indian Mus., **7 :** 74. (*Erionomus.*)

The density of the hairy covering of the sides of the metasternum seems to vary somewhat probably due to the condition of the specimen. A readily distinguished species, common and widely distributed in tropical Africa.

Coll. Musée du Congo : 1 ex. Bas-Uele : Bambesa, 1930 (*Liontovitch*); 1 ex. Equateur (*Verlaine*); 1 ex. Ituri : Kakole (Lubutu), 2.xi.1929 (*A. Collart*); 2 exs. Leverville, 1928 (*Mme. J. Tinant*); 2 exs. Eala, 1921 (*Lt. Ghesquière*); 1 ex. Wendji, 18.viii.30 (*M. Vrydagh*); 1 ex. Bas-Uele : Buta, 1930 (*Fr. Joseph*); 1 ex. Kafakumba, i.1931 (*F. G. Overlaet*); 4 exs. Eala, 4.x.1931 (*H. J. Bredo*).

Coll. Hincks : 2 exs. Kasai (Ex. Coll. *E. C. Horrell*); 10 exs. Kinda : Katanga (via *Staudinger*); 17 exs. Buta (via *Staudinger*).

Pentalobus barbatus (Fab.).

Fabricius, 1801, Systema Eleuther., **2** : 256. (*Passalus.*)
Percheron, 1835, Mon. Passales, 33, t. 2, f. 8. (*Passalus.*)
Burmeister, 1847, Handb. Entom., **5** : 475. (*Passalus.*)
Kaup, 1868, Coleopt. Hefte, **3** : 18.
Kaup, 1871, Berlin. Ent. Z., Suppl., **15** : 34.
Kuwert, 1891, Deuts. Ent. Z., **35** : 191; 1898, Novit. Zool., **5** : 312.
Gravely, 1918, Mem. Indian Mus., **7** : 73.

This common species is very widely distributed over the whole of tropical Africa and is very variable in size and proportions. Like Gravely I have not succeeded in finding any constant specific characters in the variable material seen.

Typical *barbatus* in good condition have the lateral areas of the metasternum covered with more or less dense hairs, which are often partly denuded in old or worn examples but appear to be always visible to some extent. In smaller examples the pubescence is less dense, whilst in the small specimens standing in collections under the name of *P. savagei* (Perch.) it appears to be always absent. This is the only character in which *savagei* differs from *barbatus* except for the smaller size and differences of puncturation which are found in larger and smaller specimens of many species of Passalidae. I therefore tentatively regard *savagei* as a variety of *barbatus*.

Coll. Musée du Congo : 13 exs. Lulua : Sandoa, viii.–x.1930 (*F. G. Overlaet*); 2 exs. Eala, 1921 (*Lt. Ghesquière*); 2 exs. Eala, 4–17.x.31 (*H. J. Bredo*); 1 ex. Eala–Bokatola–Bikoro, ix.–x.1930 (*Dr. P. Stauer*); 28 exs. Leverville, 1928 (*Mme. J. Tinant*); 9 exs. Mongbwalu (Kilo), 1930 (*Mme. E. Milliau*); 2 exs. Bas-Uele : Bambusa, 1930 (*Liontovitch*); 2 exs. Bas-Uele : Buta, 1930 (*Fr. Joseph*); 5 exs. Buta (*S. M. Reine Elisabeth*); 1 ex. Equateur : Flandria, fin 1928 (*R. P. Hulstaert*); 1 ex. Equateur : Baende, 1928 (*R. P. Hulstaert*); 1 ex. Barumbu, 14.xii.1920 (*Lt. Ghesquière*); 3 exs. Aruwimi : Panga, x.–xii.1925 (*Eug. Bock*); 1 ex. Ituri : Masua (Lubutu), 27.ix.1929 (*A. Collart*); 1 ex. Sankuru : Lodja, iv.1929 (*J. Ghesquière*); 1 ex. Kwango, 1925 (*P. Vanderijst*); 1 ex. Lukakla, vii.1923 (*H. Lebeau*); 28 exs. Kafakumba, xi., xii., 1930, i., ii., v., 1931 (*F. G. Overlaet*); 14 exs. Léopoldville, 1930 (*A. Tinant*); 1 ex. Libenge (*Vrenrick*); 6 exs. Lomami : Kisamba, i.1931 (*P. Quarré*); 4 exs. Katanga : Katompe, ii.1929 (*Ch. Seydel*).

Coll. Hincks : 15 exs. Kinda : Katanga (via *Staudinger*); 22 exs. Bas-Uele : Buta (via *Staudinger*); 1 ex. Kasai (ex. Coll. *E. C. Horrell*); 5 exs. Belgian Congo (via *Staudinger*).

var. *savagei* (Perch.).

Percheron, 1844, Mag. Zool., 6, t. cxxxiv. f. 4. (*Passalus.*)
Burmeister, 1847, Handb. Entom., **5** : 476. (*Passalus.*)
Kaup, 1868, Coleopt. Hefte, **3** : 18; 1871, Berlin. Ent. Z., Suppl., **15** : 34.
Kuwert, 1891, Deuts. Ent. Z., **35** : 192; 1898, Novit. Zool., **5** : 312.
ab. *simia*, Kuwert, *loc. cit.*, 1898, **5** : 312.
barbatus (pars.). Gravely, 1918, Mem. Indian Mus., **7** : 73.

Coll. Musée du Congo : 1 ex. Eala, 1921 (*Lt. Ghesquière*); 10 exs. Sankuru :

Komi (Lodja), ii.–iv.1930 (*J. Ghesquière*); 2 exs. Sankuru: Kondue (*Ed. Luja*); 1 ex. Kivu: Buseregenye (Rutshuru), ix.1929 (*Ed. Luja*); 2 exs. Bas-Uele: Koteli, 1–21.i.25 (*Dr. H. Schouteden*).

Coll. Hincks: 3 exs. Buta (via *Staudinger*).

Didymus, Kaup.

Kaup, 1871, Berlin. Ent. Z., Suppl., **15** : 30.
Aurivillius, 1886, K. Svenska Vet. Akad. Handl., **12** : 18.
Kuwert, 1891, Deuts. Ent. Z., **35** : 191; 1896, Novit. Zool., **3** : 228; *loc. cit.*, 1898, **5** : 306.
Eumelosomus, Kuwert, *loc. cit.*, 1891, **35** : 190; *loc. cit.*, 1896, **3** : 228; *loc. cit.*, 1898, **5** : 302.
Didimoides, Kuwert, *loc. cit.*, 1891, **35** : 191; *loc. cit.*, 1896, **3** : 228; *loc. cit.*, 1898, **5** : 309.
Pentalobus (pars.), Gravely, 1918, Mem. Indian Mus., **7** : 69, 72.

Type: *D. laevis* (Klug), 1835.

The species of this genus are rather difficult to tabulate satisfactorily. It was hoped originally to utilise the form of the lateral areas of the metasternum as a primary character. In one section of the genus these are broadly expanded on the inside behind the middle whilst in another they are more or less parallel-sided. Unfortunately the distinction is not a sharp one and cannot therefore be used as a primary character for grouping the species. Kuwert separated the species into two genera on the characters afforded by the secondary tubercles of the anterior margin of the head, but this again is open to objection as in several of the species in which the head margin is said to possess two secondary tubercles (part of *Didymus*, Kuw.) specimens often occur where these are closely approximated and also even fused to form a single tubercle. Gravely has used the same characters to divide his genus *Pentalobus*.

It is believed that the last (visible) abdominal segment will be found to yield valuable confirmatory characters in many species. It is true that such characters vary somewhat in details, but in the long series of specimens examined the general type has been found to be very constant in certain species.

The trivial and variable characters used by Kuwert to subdivide his genera have made it impossible in many cases to recognise his species, a number of which are no doubt quite distinct. Several species of the older authors have been sources of considerable confusion, and a number of points need elucidation before a satisfactory synonymy of the species can be made.

The *Passalus cayor* of Percheron (1835, 67, t. v, f. 2) described as coming from either Senegal or Brazil and referred by Kaup and Kuwert to an American species is probably an African form as suggested by Gravely (1918, p. 11), and from the figure given by Percheron would appear to be a *Didymus*. Gravely also suggests that *P. hostilis*, Perch. (1841, pl. lxxvii, f. 4) is an African species, although Kaup and Kuwert have associated the name with an American form.*

Key to the Species of Didymus.

1. Last abdominal segment with a deep and rather broad groove behind on either side; a single strong secondary tubercle present on the anterior margin of the head. Lateral areas of the metasternum broad and expanded inwards behind middle . . . . . 2.
   Last abdominal segment without grooves behind or the lateral areas of the metasternum are more or less parallel-sided . . . . . 3.
2. Abdominal scars almost entirely unpunctured or only punctured to a

* Since these notes were written, I have received a copy of Herr H. Luederwaldt's "Monographia dos Passalideos do Brasil" (1931, Revista Mus. Paulista, **17** : 3–264) in which the author discusses the position of *P. hostilis* (*loc. cit.*, 198–200, sep. 196–198).

limited extent. Antennal lamellae long. Frontal area very rugose but without definite median ridge, about as broad as long. Frontal ridges diverging at about a right angle, less curved than in *africanus*. Elytral ridges reaching apex of elytra, the lateral grooves transversely punctured and in the outermost, at least towards apex, the punctures are broken up into smaller punctures. Metasternal plate smooth and unpunctured, posterior intermediate areas with a small group of punctures. L. 27–31 mm. . . . . *D. aloysii sabaudiae* (Pangella).

Abdominal scars strongly and distinctly punctured. Antennal lamellae long. Frontal area rather longer than broad often with a well-defined median ridge. Frontal ridges diverging at about a right angle in front of the central tubercle and less divergent in front of the inner tubercles particularly in smaller specimens. The depressed portions of the head and the sides of the thorax are strongly and coarsely punctured. Lateral grooves of the elytra very transversely punctured, the punctures in the outermost groove are much broken up. Metasternal plate as a rule with scattered punctures and the posterior intermediate areas closely and strongly punctured. L. 15·5–21 mm. . . . . *D. nachtigalli* (Kuwert).

3. Lateral areas of the metasternum distinctly expanded inwards behind the middle and generally broader. Last abdominal segment without grooves 5.

Lateral areas of metasternum more or less parallel-sided and narrow and not expanded inwards behind middle. Last abdominal segment with indistinct apical grooves or with a transverse ∧-shaped fold . . . . 4.

4. Last abdominal segment as a rule strongly and rugosely punctured all over with an indistinct apical groove on either side. Frontal area broader than long. Inner tubercles closer to the outer tubercles and almost as widely separated from one another as the latter. Outer tubercles as a rule not projecting strongly beyond the anterior margin of the head and less strongly developed than the outer marginal tubercles. Frontal ridges diverging at a very obtuse angle. The general line of the anterior margin of the head is straight. The eyes are strongly rounded and somewhat prominent exteriorly. Fore angles of thorax less produced. L. 14–15 mm. . . . . *D. ealaensis*, sp. n.

Last abdominal segment has a more or less distinct transverse ∧-shaped fold and an apical keel. Eyes less prominent and flattened exteriorly. Frontal area less transverse. Inner tubercles less close to the outer tubercles and situated nearer to each other than the latter which project more strongly beyond the head margin and as a rule are as strong as the outer marginal tubercles of the head. Frontal ridges diverging in a less obtuse angle. The general line of the fore margin of the head as a rule noticeably convex. Anterior angles of the thorax more strongly produced. L. 17–20 mm. . . . . *D. punctipectus*, Kaup.

5. Elytral ridges reaching apex consequently no distinct roughened apical area present . . . . . 6.

Elytral ridges not reaching apex leaving a distinct more or less roughened apical area . . . . . 7.

6. Last abdominal segment completely covered with punctures without tuft of hairs. Antennal lamellae rather short. Anterior margin of head with a median secondary tubercle. Frontal area as broad or broader than long. Frontal ridges diverging in a very obtuse angle in front of the central tubercle and usually strongly curved. The thorax thickly punctured laterally. Lateral grooves transversely punctured though less strongly than usual. The outer groove has numerous small punctures. Metasternal plate impunctate or with a few punctures behind, posterior intermediate areas always impunctate. Abdominal scars closely and finely punctured. L. 22–26 mm. Rather convex form. . . . . *D. africanus* (Percheron).

Last abdominal segment with a strong tuft of hair on the apical half. The frontal area is longer than broad. The frontal ridges diverging in an acute angle. The anterior margin of the head bears in the centre two small secondary tubercles which are close together or even united in small specimens and more widely separated and often indistinct in larger examples. Mesosternal scars ovoid. The plate of the metasternum impunctate, the posterior intermediate areas with a few punctures. The anterior angles of the thorax are about right angles. The lateral grooves of the elytra strongly and uniformly punctured though not very transversely. The puncturation of the abdominal sterna is confined to the strongly impressed scars. Narrow and rather flattened form. L. 17·5–26·5 mm.

D. ruwenzoricus, Arrow.

7. Two outermost grooves of the elytra with the punctures more or less obsolete. The anterior margin of the head between the outer tubercles straight with two small, inconstant secondary tubercles; puncturation of the head and the shape of the frontal area somewhat variable. The anterior angles of the thorax somewhat produced. The seventh and eighth grooves of the elytra strongly and distinctly punctured, less transversely and less distinctly in smaller specimens. Plate of metasternum with an apical group of punctures and the posterior intermediate areas with larger and stronger groups. Last abdominal segment finely and closely punctured, as a rule all over though less closely in the centre which may be impunctate in some specimens. The sides of this segment bear broad shallow depressions and the apex is emarginate. L. 21–29 mm.

D. congoensis, Arrow.

All lateral grooves of the elytra strongly and distinctly punctured. Anterior margin of the head with a small median concavity, in unworn examples, on either side of which there are only indistinct secondary tubercles. The sides of the thorax are strongly punctured throughout and their anterior angles are not produced. The outermost groove of the elytra usually with distinct double puncturing. The last abdominal segment is rather more strongly and rugosely punctured with the apex strongly emarginate. Abdominal scars and sides more strongly and rugosely punctured and dull. L. 21–26 mm. . . . . *D. parastictus* (Imhoff).

Didymus africanus (Perch.). Plate V, fig. 5.

Percheron, 1844, Mag. Zool., 10, t. cxxxv, f. 2. (*Passalus.*)
Arrow, 1906 (1907), Trans. Ent. Soc. Lond., **1906** : 445.
laevipectus, Aurivillius, 1886, K. Svenska Vet. Akad. Handl., **12** : 16 (as *D. duplicatus*, Har. var.).
„ Kuwert, 1891, Deuts. Ent. Z., **35** : 190; 1898, Novit. Zool., **5** : 302. (*Eumelosomus.*)

Mr. Arrow has already pointed out that earlier authors erroneously synonymised this species with *D. parastictus* (Imh.). According to Kuwert it is distinguished from *D. klugi*, Kaup, by the absence of punctures on the metasternum, at the apex of which plate *D. klugi* is said to have one or two punctures. The series before me, however, contains punctured specimens which differ from the rest of the series in no material characters. A specimen in my collection determined as *D. klugi* by Richard Zang is also referable to this species and differs only in the presence of the scanty punctures above mentioned. I am therefore very doubtful as to the true status of *D. klugi* as described by Kuwert. On the other hand, I have seen, by the kindness of Mr. Arrow, a specimen from the British Museum collection determined as *D. klugi* by Gravely. This is smaller than typical *D. africanus* and has the frontal area much less distinctly transverse and the frontal ridges more acutely angled behind. In *D. africanus* there is some variation in the shape of the frontal area and in the form of the

frontal ridges, but in my specimens the former is usually very transverse and the latter diverge at an obtuse angle and are somewhat strongly curved. The series in the collection of the Congo Museum are all apparently referable to *D. africanus*.

Coll. Musée du Congo: 1 ex. Kasai: Bashishombe, 8.viii.1921 (*Lt. Ghesquière*); 1 ex. Kasai: Luebo (*don. G. Babault*); 1 ex. Sandoa, x.1930 (*F. G. Overlaet*); 1 ex. Barumbu, 29.i.21 (*Lt. Ghesquière*); 1 ex. Equateur: Ngona, 23.ix.26 (*R. P. Hulstaert*); 1 ex. Leverville, 1928 (*Mme. J. Tinant*); 1 ex. Mongbwalu (Kilo), 1930 (*Mme. E. Milliau*); 2 exs. Libenge (*Mr. Vrenrick*); 7 exs. Lulua: Kapanga, v.1931 (*F. G. Overlaet*); 2 exs. Eala, 4–14.x.31 (*H. J. Bredo*).

Coll. Hincks: 2 exs. Kasai (Ex Coll. *E. C. Horrell*); 2 exs. Entre Lacs Kivu et Edmond (via *Clermont*); 2 exs. Medje (via *Staudinger*); 1 ex. Belg. Congo (via *Staudinger*).

Didymus aloysii sabaudiae (Pangella). Plate V, figs. 6, 14.

Pangella, 1906, Boll. Mus. Zool. Anat. comp., Torino, **21**, No. 540; 13th Nov. 1906. (*Eumelosomus.*)

affinis, Arrow, 1907, Trans. Ent. Soc. Lond., **1906**: 465, Jan. 1907; 1909, Trans. Zool. Soc. Lond., **19** : 187. (*Eumelosomus.*) (n. syn.)

In reading over the brief "diagnosi preventiva" of Pangella I was struck by the similarity of his description to specimens which I had named *D. affinis*, one of which had been compared with the type by Mr. Arrow. Pangella does not, however, describe the abdominal sterna which are characteristic in *affinis*. By the kindness of the Director of the Musei di Zoologia ed Anatomia Comparata, Turin, I have been able to see one of Pangella's two specimens and it is at once evident that this species is the *D. affinis* of Arrow. The differences between the Turin specimen and the one compared by Mr. Arrow are very slight and are only individual. Similar differences can be seen amongst the individuals of the series from Belgian Congo. *D. aloysii sabaudiae* is closely allied to *D. sansibaricus*, Har., but is readily distinguished by having the scars of the abdominal sterna almost impunctate or punctured to only a very limited extent at the extreme sides. The frontal area differs also; in *D. sansibaricus* there is always (or nearly always) a straight longitudinal median carina from the frontal angle to the secondary tubercle of the head margin, whilst in the present species the frontal area has several irregular more or less sinuous ridges or grooves but no trace of a median carina. The head and the metasternal posterior areas are more sparingly punctured in *D. aloysii sabaudiae*.

Coll. Musée du Congo: 2 exs. Ituri: Lubero, i.29 (*Mme. Van Riel*); 1 ex. Ituri: Lubero (1900 m.), xi.28 (*Mme. Van Riel*); 3 exs. Kivu: Buseregenye (Rutsbruru), ix.–x.1929 (*Ed. Luja*); 1 ex. Kilo: Mines, 9.iii.1929 (*R. P. Thalman*); 2 exs. Katanga: Lukafu, 6–22.xii.30 (*G. F. de Witte*).

Didymus nachtigalli (Kuwert). Plate V, fig. 7.

Kuwert, 1891, Deuts. Ent. Z., **35** : 190; 1898, Novit. Zool., **5** : 306. (*Eumelosomus.*)

communis, Kuwert, *loc. cit.*, 1898, **5** : 306. (*Eumelosomus.*) (n. syn.)

I am unable to find any constant specific distinction between this form and the common *D. sansibaricus* (Har.). It is probable that Gravely includes this in his *D. sansibaricus* (*loc. cit.*, 1918, **7** : 73) when he gives the length as 16·5–27·5 mm. I should be inclined to follow Gravely were it not for the fact that I have seen no typical *sansibaricus* from Belgian Congo, though my collection

contains specimens from the French territory. I prefer therefore to regard *D. nachtigalli* tentatively as a distinct species.

Typical *D. sansibaricus* measure 24–29 mm. long, whilst the present form varies from 15·5–21 mms., and I have seen no intermediates in size in nearly 300 specimens. The other differences appear to be those which are usually found between large and small specimens of the same species in PASSALIDAE. The lateral grooves of the elytra are more transversely punctured particularly in the smallest specimens of *D. nachtigalli*, and in these also the whole of the metasternum is more or less covered with punctures whilst larger specimens may have only the posterior intermediate areas punctured as in *D. sansibaricus*. Smaller specimens have the puncturing of the abdominal sterna more extensive.

A series of *D. nachtigalli* determined by Kuwert agree well with the larger specimens in the material before me in which the metasternal plate has few punctures. Rather smaller examples with the plate more thickly punctured agree with specimens determined by Kuwert as *D. communis*. There is no specific difference between the two and *D. büttneri* (Kuw.) (*loc. cit.*, 1898, **5 :** 305) is probably also the same species.

Musée du Congo : 3 exs. Equateur : Flandria, x.28 (*R. P. Hulstaert*); 3 exs. Ubangi : Libenge (*Vrenrick*); 2 exs. Eala, 4.x.31 (*H. J. Bredo*); 11 exs. Lulua : Kapanga, v.1931 (*F. G. Overlaet*); 1 ex. Lomami : Lusuku, ix.1930 (*P. Quarré*); 1 ex. Ituri : Mahagi, 1931 (*Ch. Scops*); 1 ex. Kafakumba, ii.1931 (*F. G. Overlaet*).

Coll. Hincks : 4 exs. Buta (via *Staudinger*).

Didymus ruwenzoricus, Arrow. Plate V, figs. 3, 11.

Arrow, 1907, Trans. Ent. Soc. Lond., **1906** : 464; 1909, Trans. Zool. Soc. Lond., **19** : 186.

Typical specimens have been compared with a cotype kindly lent by Mr. Arrow. Smaller and larger specimens vary somewhat in detail but agree in the more important characters of the elytral sculpture, the abdominal scars and the last abdominal segment.

Musée du Congo : 3 exs. Congo Oriental, 1930; 1 ex. Beni (*Lt. Borgerhoff*); 1 ex. Haut Uelé : Moku Moto, 20.ii.27 (*L. Burgeon*); 1 ex. Haut Uelé : Moto, 1923 (*L. Burgeon*); 2 exs. Ituri (Sud), xii.21 (*A. Pilette*); 1 ex. Ituri : Mahagi-Port, 1931 (*Ch. Scops*); 2 exs. Mongbwalu (Kilo), 1930 (*Mme. E. Milliau*); 1 ex. N. Kivu : Lulengu, xii.1927 (*Ch. Seydel*); 2 exs. Kivu : Tshibinda, xii.1927 (*Ch. Seydel*).

Didymus congoensis, Arrow. Plate V, figs. 1, 8 and 10.

Arrow, 1906 (1907), Trans. Ent. Soc. Lond., **1906** : 463.

The majority of the specimens which I refer here agree well with a cotype loaned by Mr. Arrow and with specimens from various sources determined by him. Besides these I have seen a number of individuals which differ from typical *congoensis* in the puncturation of the lateral grooves of the elytra. These are often smaller than typical specimens and have the puncturation less transverse and less clearly defined and have the frontal area somewhat narrower. There appears to be no possibility of separating these as the characters of the two merge one into the other, and both are consequently here referred to *D. congoensis*.

The smaller specimens may be the same as the two examples which Gravely refers to *parastictus* (Imh.), but as mentioned below it seems probable that Gravely did not know the true *parastictus*.

In my collection there are specimens said to be determined by Kuwert as *D. duplicatus*, Har. (from Gaboon and Cameroon), which show a further reduction in the degree of puncturation of grooves 7 and 8 and are probably not specifically distinct from the present species.

There is considerable variation in the puncturation of the sides of the thorax and head but no characters of specific value can be obtained therefrom.*

Musée du Congo : 4 exs. Ituri : Nduye-Makara, ix.–xi.1921 (*A. Pilette*); 1 ex. Ituri : Mongbwalu, xi.1929 (*Mme. Milliau*); 4 exs. Equateur : Flandria, i.–iv.1929 (*R. P. Hulstaert*); 1 ex. Equateur : Bokote, 1922 (*R. P. Hulstaert*); 1 ex. Equateur (*Verlaine*); 1 ex. Lulonga : Befale, ix.1922 (*L. Ghesquière*); 4 exs. Eala, 1921 (*Lt. Ghesquière*); 1 ex. Eala, 1922 (*M. Gossens*); 10 exs. Eala, 4.v.31 (*H. J. Bredo*); 1 ex. Barumbu, viii.1925 (*J. Ghesquière*); 2 exs. Mongbwalu (Kilo), 1930 (*Mme. E. Milliau*); 1 ex. Leverville, 1928 (*Mme. J. Tinant*); 1 ex. Thysville, 1930 (*Dr. Vanderhargen*); 8 exs. Lulua : Kapanga, v.1931 (*F. G. Overlaet*); 15 exs. Lulua : Sandoa, ix.–x.1930 (*F. G. Overlaet*); 4 exs. Lomami : Kamina, 1930 (*R. Massart*); 1 ex. Lomami : Kishinde, ix.1931 (*P. Quarré*); 1 ex. Lomami : Kisomba, i.1930 (*P. Quarré*); 2 exs. Gazi, vi–vii.1919 (*M. Mesdagh*).

Coll. Hincks : 5 exs. Belgian Congo (via *Staudinger*).

Didymus parastictus (Imhoff).

Imhoff, 1843, Ber. Verh. Naturf. Ges. Basel, **5** (1840–1842) : 171–172 (*Passalus.*)
Burmeister, 1847, Handb. Entom., **5** : 476. (*Passalus.*)
Kaup, 1868, Coleopt. Hefte, **3** : 11; 1871, Berlin. Ent. Z., Suppl., **15** : 30.
Kuwert, 1898, Novit. Zool., **5** : 309.

Very closely allied to *D. congoensis* from which it is most readily distinguished by having the lateral grooves of the elytra strongly and equally clearly punctured. The two outermost grooves in *D. congoensis* have the punctures effaced and the grooves appear more polished.

Gravely's *parastictus* † does not appear to agree with the species so named by Burmeister, Kaup and Kuwert. Specimens in my collection determined by the latter agree with the material in the collection before me for which I have used Imhoff's name. Gravely's species is closely allied to, if not identical with the form referred to above as *D. congoensis*.

Musée du Congo : 2 exs. Ituri : Nduye-Makara, ix.–x.1921 (*A. Pilette*); 1 ex. Ituri : Medje, 1.iv.1914 (*Dr. Christy*); 4 exs. Bas-Uele : Buta, 1930 (*Fr. Joseph*); 1 ex. Watsa à Niangara, vii.1920 (*L. Burgeon*).

Didymus ealaensis, sp. n. Plate V, figs. 4, 9 and 13.

The club of the antennae has three stout and moderately long lamellae. The fore margin of the labrum is almost straight. The general line of the front of the head is straight. The frontal ridges diverge one from the other in an obtuse angle as far as the inner tubercles which are separated nearly as widely as the outer tubercles to which they approximate more nearly than in *D. punctipectus*. From the inner tubercles the ridges bend sharply

* Since writing the above I have had the opportunity of examining a cotype of *D. curvilineatus*, Arrow (1907), and find that I have included in *congoensis* specimens which would be referable to the former. Whether these can be regarded as specifically distinct is problematical, as the material is not now available for a re-examination and the few specimens I now have before me are quite inadequate. I am at present, however, collecting material for a revision of the difficult *congoensis* group and hope to be able to offer some further remarks on this question.

† A specimen in the British Museum collection bearing Gravely's determination label is *D. laevisternus*, Arrow (1907), but this is not the form named *parastictus* by Gravely in 1918.

and continue an almost parallel course to the fore margin. In front of the inner tubercles the ridges are weaker. The outer tubercles are as a rule not very prominent and extend only a short distance beyond the anterior margin of the head. The frontal area is distinctly transverse and has a number of large ring punctures. The raised portions of the head are strongly but finely punctured and the depressed areas have numerous ring punctures. The anterior margin of the head has two rather strong secondary tubercles in unworn examples which are usually rather widely separated, the space between them being almost straight. The outer marginal tubercles of the head are the strongest and most evident. The eyes are rounded and rather prominent.

The thorax is transverse and has the anterior angles only slightly produced. The lateral border is broad and strongly punctured and the sides of the thorax are strongly and extensively punctured leaving an indefinite unpunctured area immediately above the thoracic border. There are scattered punctures on the disc and the central groove is incomplete in front and behind. The dorsal grooves of the elytra are indistinctly punctured, the lateral ones have transverse punctures less distinct than usual as the connecting rods and ridges are rather broad. The transverse punctures in the outermost groove are not distinctly split up into smaller punctures. The ridges reach the apex of the elytra.

The prosternal process is broad and has a few large punctures in the centre. The shining mesosternum has a large patch of very fine and close punctures particularly marked towards the base. The scars are linear, shallow and punctured. The whole of the metasternal plate and the posterior intermediate areas bear scattered large punctures. The lateral areas are uniformly narrow. The abdominal scars are finely granulate. The whole of the last segment is covered with somewhat coarse and rugose puncturation, occasionally the centre of the segment is less distinctly punctured. On either side at the apex there is a somewhat indistinct groove. The penultimate sternite is punctured on the apical portion to a variable extent. L. 14–15 mm.

Type in Congo Museum, Eala 1921 (*Lt. Ghesquière*).

This species is closely allied to *D. punctipectus* but differs in several important characters mentioned in the key *supra*. In the table given by Kuwert in his monograph, the nearest ally would seem to be *D. simulator*, Kuw., which I know from description only but which differs in several characters from *D. ealaensis*. Kuwert's diagnosis is short and inclusive, so that it is difficult to estimate the points of similarity and difference without seeing the type specimen of *simulator*. In the latter the frontal ridges diverge in an acute angle and the outer tubercles appear to be weaker than in *ealaensis*. The last abdominal sternite has the centre unpunctured in *simulator*, which is a larger insect 18 mms. long.

Musée du Congo : 5 exs. Eala, 1921 (*Lt. Ghesquière*); 2 exs. Eala, 4.x.31 (*H. J. Bredo*); 3 exs. Region des Lacs (*Dr. Sagona*).

Didymus punctipectus (Kaup). Plate V, figs. 2 and 12.

Kaup, 1868, Coleopt. Hefte, **3** : 11; 1871, Berlin. Ent. Z., Suppl., **15** : 30.
Gravely, 1918, Mem. Indian Mus., **7** : 73, f. viii, 3, p. 70.
carnifex, Kuwert, 1898, Novit. Zool., **5** : 308. (n. syn.)
,, Arrow, 1906 (1907), Trans. Ent. Soc. Lond., **1906** : 462.
livingstoni, Kuwert, *loc. cit.*, 1898, **5** : 309. (n. syn.)

I base my determination of this species on a specimen in the British Museum collection believed to have been named by Kaup, which agrees well with Kaup's description and with Gravely's interpretation of the species. It appears, however, that Kuwert's *D. punctipectus* (Kuwert, *loc. cit.*, 1898 : 309), is not the present insect. Whether Kuwert actually had specimens which exhibit the characters he gives for *D. punctipectus* or whether the description merely represents what the author considered to be a copy of Kaup's may be disclosed

when the Kuwertian collection becomes available for study. At present all that can be said is that *D. punctipectus* of Kuwert belongs to the *parastictus* group of species in which the fore margin of the head possesses a medial concavity not flanked by distinct tubercles, which is very different from the interpretation here accepted.

The British Museum specimen is rather small (17 mms.), but otherwise I can see no differences of specific value between it and specimens in the Congo Museum material which I had named *D. livingstoni*, Kuw., and which I have since seen agree with Kuwert's type preserved in the Berlin Zoological Museum.

With regard to *D. carnifex*, Kuw., some specimens in the Congo Museum material were originally identified with this form and considered as a variety of *D. livingstoni*. I have since seen a specimen from the series determined by Mr. Arrow as *D. carnifex*, and this agrees with my specimens. The degree of puncturation of the metasternum is not constant in *D. punctipectus* so that *carnifex*, which is said to differ in having the posterior intermediate areas almost impunctate, is perhaps better considered as a synonym, particularly as I have seen examples which are intermediate between them.

Probably other Kuwertian names will have to be referred here.

The last abdominal segment varies somewhat but is usually covered with punctures, less closely at the centre and has a transverse broadly ∧-shaped fold and a longitudinal apical keel. These characters vary in clearness but appear to be always present to some degree.

Musée du Congo : 1 ex. Sankuru : Kondue (*Ed. Luja*); 2 exs. Equateur : Flandria, iv.28, x.–xi.1929; 1 ex. Kasai : Bashishombe, 8.viii.1921 (*Lt. Ghesquière*); 1 ex. Sankuru : Komi (Lodja), ii.1930 (*J. Ghesquière*); 2 exs. Haut Uelé : Moto, 1920 (*L. Burgeon*); 25 exs. Lomami : Mutombo-Mukulu, vi.1931 (*P. Quarré*).

Explanation of Plate V.

Figs. 1–7. Rough sketches of the heads of *Didymus* spp.

Fig. 1. *D. congoensis*, Arrow. Large form.
2. *D. punctipectus*, Kaup.
3. *D. ruwenzoricus*, Arrow.
4. *D. ealaensis*, sp. n.
5. *D. africanus* (Perch.).
6. *D. aloysii sabaudiae* (Pang.).
7. *D. nachtigalli* (Kuw.).

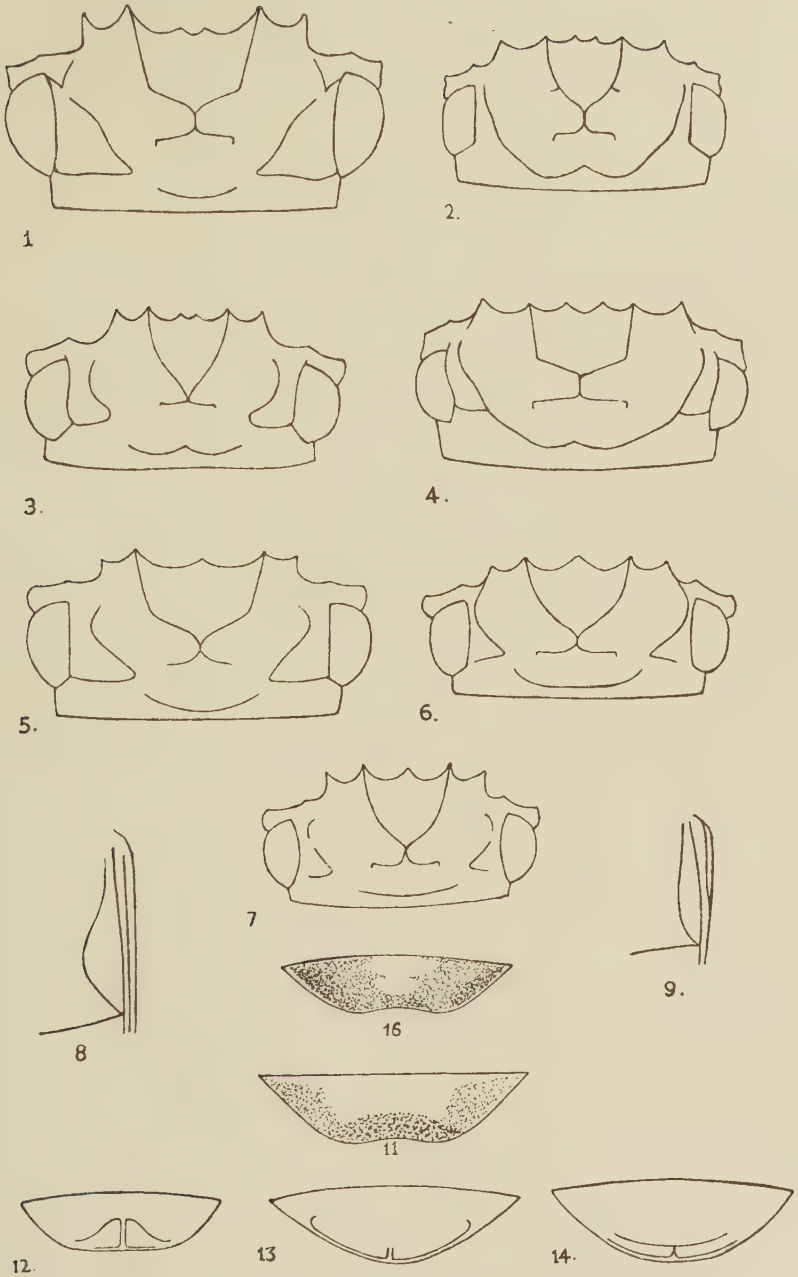
Figs. 8 and 9. Lateral areas of metasternum of *Didymus* spp.

Fig. 8. *D. congoensis*, Arrow.
9. *D. ealaensis*, sp. n.

Figs. 10–14. Rough sketches of the last visible ventral abdominal segment of *Didymus* spp.

Fig. 10. *D. congoensis*, Arrow.
11. *D. ruwenzoricus*, Arrow.
12. *D. punctipectus*, Kaup.
13. *D. ealaensis*, sp. n.
14. *D. aloysii sabaudiae* (Pang.).

My thanks are due to my friend Mr. J. R. Dibb, F.R.E.S., for the sketches here reproduced.



Passalidæ of the Belgian Congo.

A CATALOGUE OF THE BRITISH BRACONIDAE*

By G. T. Lyle.

[Read 7th December, 1932.]

Preface.

Although Desvignes (1856), Marshall (1870) and Morley (1914) have published lists of the British Ichneumonidae, no list of the British Braconidae has yet appeared. The want of such a list has been much felt by students, alas very few in number, of a most interesting group of insects and, moreover, one which is of very considerable economic importance. However, it is pleasing to find that probably at no period during the past quarter of a century has so much interest been taken in the Braconidae as at the present time, and it is in the hope of fostering this interest that I am publishing the following list.

Much work remains to be done even with our British species, particularly in the groups Exodontes and Flexiliventrini, and it is quite certain that when more attention is given to these groups numerous additions will be made to our list of species; while even a study of the biology of the very much better known Areolarini continually brings new facts to light.

I have followed the classification of Forster so far as it has been used by Szépligeti in the "Genera Insectorum" with the exception that I have copied Marshall in discarding the genera *Amicroplus* and *Zemiotes*; the former seems to me to have been created for very insufficient reasons and the latter was erected to take two species of *Meteorus* which have "the radial cell of the hind wing geminated by a transverse nervure." In one of these species, *M. albiditarsis*, Curtis, the character is always well marked but in the other, *M. caligatus*, Hal., this is not so; in sixteen examples (♂♂ and ♀♀) in my own collection one only has the dividing nervure prominent, in several it shows under magnification but is colourless, while in others even considerable magnification discloses no evidence of the gemination. Also signs of this dividing nervure are occasionally found in another species, *M. chlorophthalmus*, Nees. It is very evident, therefore, that the genus *Zemiotes* cannot stand.

I should like to take this opportunity of thanking my friends Bernard S. Harwood, the late W. J. Lucas, B.A., F.E.S., Claude Morley, F.Z.S., F.E.S., and the late Jas. Waterston, M.A., D.Sc., F.E.S., for kindly help.

June 1929.

Group CYCLOSTOMINI, Wesmael.

Subfamily Braconinae, Forster.

Vipio, Latreille.
terrefactor, Villers.
Glyptomorpha, Holmgren.
guttiventris, Thom.
Coeloides, Wesmael.
scolyticida, Wesm.
melanotus, Wesm.
Baryproctus, Ashmead.
barypus, Marshall.
Bracon, Fabricius.
pectoralis, Wesm.
laetus, Wesm.
scutellaris, Wesm.
erythrostictus, Marsh.
intercessor, Nees.
flavipes, Nees.
minutator, Fab.
Bracon, *continued.*
fulvipes, Nees.
tenuicornis, Wesm.
longicollis, Wesm.
variegator, Nees.
nigratus, Wesm.
virgatus, Marsh.
erraticus, Wesm.
subcylindricus, Wesm.
exarator, Marsh.

* MSS. received for publication after the death of the author.

Bracon, *continued.*
triangularis, Nees.
roberti, Wesm.
laevigatus, Ratz.
mediator, Nees.
vectensis, Marsh.
hylobii, Ratz.
fuscicoxis, Wesm.
aequalis, Thom.
= *tornator*, Marsh.
guttiger, Wesm.
satanus, Wesm.
fraudator, Marsh.
epitriptus, Marsh.
larvicida, Wesm.
praetermissus, Marsh.
colpophorus, Wesm.
abscissor, Nees.
discoideus, Wesm.
regularis, Wesm.
piger, Wesm.
caudatus, Ratz.
ratzeburgi, Dalla T.
= *longicaudis*, Ratz.
terebella, Wesm.
urinator, Fab.
oostmaeli, Wesm.
bipartitus, Wesm.
= *otiosus*, Marsh.
variator, Nees.
bisignatus, Wesm.
= *degenerator*, Marsh.
osculator, Nees.
obscurator, Nees.
anthracinus, Nees.
atrator, Nees.

Habrobracon, Ashmead.
stabilis, Wesm.
brevicornis, Wesm.
instabilis, Marsh.

Subfamily
EXOTHECINAE, Forster.

Phanomeris, Forster.
dimidiatus, Nees.
fragilis, Hal.

Xenarcha, Forster.
lustrator, Hal.

Bathystomus, Forster.
funestus, Hal.

Rhysipolis, Forster.
meditator, Hal.

Exothecus, Wesmael.
braconius, Hal.
incertus, Wesm.

Subfamily
SPATHIINAE, Marshall.

Spathius, Nees.
rubidus, Rossi.
exarator, L.

Subfamily
HECABOLINAE, Forster.

Heterospilus, Haliday.
caesus, Nees.

Euchasmus, Marshall.
exiguus, Marsh.

Hecabolus, Curtis.
sulcatus, Curtis.

Subfamily
PAMBOLINAE, Marshall.

Pambolus, Haliday.
mirus, Ruthe.

Subfamily
DORYCTINAE, Forster.

Histeromerus, Wesmael.
mystacinus, Wesm.

Caenopachys, Forster.
hartigii, Ratz.

Doryctes, Haliday.
leucogaster, Nees.
imperator, Hal.
gallicus, Rein.
heydenii, Rein.
spathiformis, Ratz.
striatellus, Nees.

Subfamily
HORMIINAE, Forster.

Chremylus, Haliday.
rubiginosus, Nees.

Hormius, Nees.
moniliatus, Nees.

Subfamily
RHOGADINAE, Forster.

Rhyssalus, Haliday.
clavator, Hal.
indagator, Hal.

Colastes, Haliday.
decorator, Hal.
hariolator, Hal.

Oncophanes, Forster.
lanceolator, Nees.

Clinocentrus, Haliday.
exsertor, Nees.
striolatus, Thoms.
cunctator, Hal.
gracillipes, Thoms.
excubitor, Hal.
tenuicornis, Thoms.
vestigator, Hal.
stigmaticus, Marsh.
umbratilis, Hal.

Petalodes, Wesmael.
unicolor, Wesm.

Pelecystoma, Wesmael.
luteum, Nees.

Heterogamus, Wesmael.
dispar, Curtis.

Rhogas, Nees.
rugulosus, Nees.
dissector, Nees.
grandis, Giraud.
reticulator, Nees.
cruentus, Nees.
irregularis, Wesm.
dimidiatus, Spin.
carbonarius, Gir.*
gasterator, Jurine.
geniculator, Nees.
tristis, Wesm.
arcticus, Thoms.
bicolor, Spin.
praetor, Rein.
nigricornis, Wesm.
modestus, Rein.
circumscriptus, Nees.
testaceus, Spin.
vittiger, Wesm.
cantherius, Lyle.
armatus, Wesm.

* Mr. Claude Morley informs me that he has British examples in his collection.

Group CRYPTOGASTRINI, Wesmael.

Subfamily SIGALPHINAE, Forster.

Allodorus, Forster.
lepidus, Hal.
semirugosus, Nees.
Sigalphus, Latreille.
caledonicus, Marsh.
caudatus, Nees.
floricola, Wesm.
striatulus, Nees.
obscurellus, Nees.
pallidipes, Nees.
luteipes, Thoms.
ambiguus, Nees.
thoracicus, Curtis.

Subfamily CHELONINAE, Forster.

Chelonus, Jurine.
inanitus, L.
speculator, Marsh.
Chelonus, *continued.*
submuticus, Wesm.
wesmaelii, Curtis.
carbonator, Marsh.
speculator, Marsh.
corvulus, Marsh.
contractus, Nees.
decorus, Marsh.
dispar, Marsh.
gravenhorstii, Nees.
canescens, Wesm.
catulus, Marsh.
pusio, Marsh.
risorius, Reinh.
secutor, Marsh.
parcicornis, Schaff.
sulcatus, Nees.
lateunculus, Marsh.
exilis, Marsh.
basilis, Curtis.
Ascogaster, Wesmael.
tritoma, Marsh.
Ascogaster, *continued.*
instabilis, Wesm.
annularis, Nees.
rufipes, Latr.
elegans, Nees.
pallidicornis, Curtis.
rufidens, Wesm.
ratzeburgii, Marshall.
canifrons, Wesm.
variipes, Wesm.
consobrina, Curtis.
bicarinata, Schaff.
fulviventris, Curtis.
armata, Wesm.
quadridentata, Wesm.
Acampsis, Wesmael.
alternipes, Nees.
Phanerotoma, Wesmael.
dentata, Panz.
bilinea, Lyle.
planifrons, Nees.

Group AREOLARINI, Wesmael.

Subfamily MICROGASTERINAE, Forster.

Elasmosoma, Ruthe.
berolinense, Ruthe.
Acoelius, Haliday.
erythronotus, Forster.
viator, Forst.
subfasciatus, Hal.
var. *germanus*, Hal.
Mirax, Haliday.
rufilabris, Haliday.
= *spartii*, Haliday.
Apanteles, Forster.
solitarius, Ratz.
anomalus, Lyle.
lineola, Curtis.
salebrosus, Marsh.
tetricus, Rein.
ruficrus, Hal.
ordinarius, Ratz.
cupreus, Lyle.
vestalis, Hal.
congestus, Nees.
simulans, Lyle.
ferrugineus, Rein.
bignellii, Marsh.
analis, Nees.
limbatus, Marsh.
Apanteles, *continued.*
rubripes, Hal.
rubecula, Marsh.
vanessae, Rein.
glomeratus, L.
stellatarum, Bouché.
sericeus, Nees.
spurius, Wesm.
cleoceridis, Marsh.
geryonis, Marsh.
zygaenarum, Marsh.
jucundus, Marsh.
caiae, Bouché.
praepotens, Hal.
juniperatae, Bouché.
hoplites, Ratz.
gracilis, Curtis.
placidus, Hal.
nothus, Rein.
insidens, Ratz.
difficilis, Nees.
picipes, Bouché.
astrarches, Marsh.
octonarius, Ratz.
inclusus, Ratz.
abjectus, Marsh.
complanatus, Lyle.
immunis, Hal.
jugosus, Lyle.
Apanteles, *continued.*
caberae, Marsh.
popularis, Hal.
gonopterygis, Marsh.
punctiger, Wesm.
laetus, Marsh.
adjunctus, Nees.
lictorius, Rein.
falcatus, Nees.
cultrator, Marsh.
ultor, Rein.
decorus, Hal.
dilectus, Hal.
xanthostigmus, Hal.
contaminatus, Hal.
praetor, Marsh.
emarginatus, Nees.
nanus, Rein.
obscurus, Nees.
tenebrosus, Wesm.
viminitorum, Wesm.
sodalis, Hal.
albipennis, Nees.
impurus, Nees.
ononidis, Marsh.
naso, Marsh.
infimus, Hal.
brevicornis, Wesm.
exilis, Hal.

Apanteles, *continued.*
butalidis, Marsh.
gagates, Nees.
halidaii, Marsh.
= *albipennis*, Hal.
coniferae, Hal.
lineipes, Wesm.
chrysostictus, Marsh.
longicaudis, Wesm.
fuliginosus, Wesm.
sicarius, Marsh.
fraternus, Rein.
triangulator, Wesm.
parallelus, Lyle.
pallidipes, Rein.
bicolor, Nees.
formosus, Wesm.
lucifugus, Lyle.
lautellus, Marsh.
umbellatarum, Hal.
callidus, Hal.
lateralis, Hal.
nigripes, Ratz.
vitripennis, Curtis.
pinicola, Lyle.
fulvipes, Hal.
liparidis, Bouché.

Microgaster, Latreille.
alvearia, Fab.
postica, Nees.
flavipes, Hal.
minuta, Rein.
marginata, Nees. } *Diolcogaster*, Ashmead.
calceata, Hal. } *Diolcogaster*, Ashmead.
circumvecta, Lyle. } *Diolcogaster*, Ashmead.
wesmaelii, Ruthe.
connexa, Nees.
dorsalis, Nees.
tiro, Rein.

Microgaster, *continued.*
suffoliciensis, Morley.
russata, Hal. } *Hygroplites*, Thomson.
abdominalis, Nees. } *Hygroplites*, Thomson.
rugulosa, Nees. } *Hygroplites*, Thomson.
scotica, Marsh.
stictica, Ruthe.
novicius, Marsh.
subcompleta, Nees.
globata, Nees.
tibialis, Nees.
meridiana, Hal.
messioria, Hal.
hospes, Marsh.
crassicornis, Ruthe.
spreta, Marsh.
polita, Marsh.
anomalon, Curtis.*
atrator, Curtis.*

Microplitis, Forster.
fumipennis, Ratz.
spinolae, Nees.
xanthopus, Ruthe.
ocellatae, Bouché.
viduus, Ruthe.
ruricola, Lyle.
tristis, Nees.
strenuus, Rein.
sordipes, Nees.
dolens, Marsh.
eremita, Rein.
spectabilis, Hal.
mediator, Hal.
medianus, Ruthe.
tuberculiferus, Wesm.
aduncus, Ruthe.
borealis, Marsh.
moestus, Ratz.

Subfamily AGATHINAE, Forster.

Neoneurus, Haliday.
halidayi, Marshall.

Orgilus, Haliday.
obscurator, Nees.
ischnus, Marsh.
micropterus, Morley.

Earinus, Wesmael.
nitidulus, Nees.
ochropes, Lyle.
delusor, Wesm.
transversus, Lyle.
tuberculatus, Wesm.

Agathis, Latreille.
malvacearum (Latr.), Nees.
nigra, Nees.
anglica, Marsh.
brevisetis, Nees.
rufipalpis, Nees.

Microdus, Nees.
conspicuus, Wesm.
= *Earinus zonatus*, Marsh.
linguarius, Nees.
nugax, Rein.
clausthalianus, Ratz.
tumidulus, Nees.
cingulipes, Nees.
pumilus, Ratz.
calculator, Fab.
brevicaudis, Rein.
rufipes, Nees.
rugulosus, Nees.
mediator, Nees.

Group POLYMORPHINI.

Subfamily CALYPTINAE, Wesmael.

Eubadizon, Nees.
extensor, L.
pallidipes, Nees.
flavipes, Hal.

Calyptus, Hal.
semicastaneus, Marsh.
puber, Hal.
tibialis, Hal.

Calyptus, *continued.*
segmentatus, Marsh.
ruficoxis, Wesm.
minutus, Ratz.
sigalphoides, Marsh.
fasciatus, Nees.

Subfamily LIOPHRONINAE, Forster.

Syrrhizus, Forster.
delusorius, Forst.

Centistes, Haliday.
fuscipes, Nees.
lucidator, Nees.
= *cuspidatus*, Hal.

Liophron, Nees.
muricatus, Hal.
lituratus, Hal.
edentatus, Hal.
ater, Nees.
saxo, Rein.

* These species were not recognised by Marshall in his Monograph of the British species but were included by Szépligeti in his Palaearctic List in the "Genera Insectorum."

Subfamily
BLACINAE, Forster.

Pygostolus, Haliday.
falcatus, Nees.
sticticus, Fab.
= *multiarticulatus,* Ratz.

Blacus, Nees.
tuberculatus, Wesm.
armatulus, Ruthe.*
diversicornis, Nees.
ruficornis, Nees.
compar, Ruthe.
maculipes, Wesm.
tripudians, Hal.
humilis, Nees.
hastatus, Hal.
instabilis, Ruthe.
paganus, Hal.
interstitialis, Ruthe.†
trivialis, Hal.
errans, Nees.
mamillanus, Ruthe.
= *aptenodytes,* Marsh.
ambulans, Hal.

Subfamily
ICHNEUTINAE, Forster.

Proterops, Wesmael.
nigripennis, Wesm.

Ichneutes, Nees.
reunitor, Nees.
brevis, Wesm.

Subfamily
MACROCENTRINAE, Forster.

Macrocentrus, Curtis.
abdominalis, Fab.
marginator, Nees.
nidulator, Nees.
thoracicus, Nees.
nitidus, Wesm.
infirmus, Nees.
equalis, Lyle.
collaris, Spin.

Homolobus, Forster.
geminator **nom. nov.,** Lyle.
= *chlorophthalmus,* Hal. nec Nees.
discolor, Wesm.

Zele, Curtis.
testaceator, Curtis.
infumator, Lyle.
chlorophthalma, Nees.
longicauda, Curtis.*
ochraceator, Curtis.*
calcarator, Wesm.*

Subfamily
HELCONINAE, Forster.

Helcon, Nees.
annulicornis, Nees.
ruspator, L.

Subfamily
DIOSPILINAE, Forster.

Dyscoletes, Westwood.
lancifer, Hal.

Dolops, Marshall.
aculeator, Marsh.
hastifer, Marsh.

Aspidogonus, Wesmael.
diversicornis, Wesm.

Diospilus, Haliday.
oleraceus, Hal.
capito, Nees.
productus, Marsh.
ovatus, Marsh.
morosus, Rein.
speculator, Hal.
ephippium, Nees.

Subfamily
OPIINAE, Forster.

Ademon, Haliday.
decrescens, Nees.

Gnamptodon, Haliday.
pumilio, Nees.

Hedylus, Marshall.
habilis, Marsh.

Biosteres, Forster.
placidus, Hal.
castaneiventris, Thom.
carbonarius, Nees.
= *procerus,* Wesm.
impressus, Wesm.
bicolor, Wesm.
haemorrhous, Hal.
blandus, Hal.
rusticus, Hal.
scabriculus, Wesm.

Biosteres, *continued.*
wesmaelii, Hal.
sylvaticus, Hal.

Diachasma, Forster.
caffer, Wesm.
cephalotes, Wesm.
fulgidum, Hal.
rugosum, Wesm.

Eurytenes, Forster.
abnormis, Wesm.

Opius, Wesmael.
lugens, Hal.
pendulus, Hal.
pygmaetor, Nees.
apiculator, Nees.
clarus, Hal.
victus, Hal.
spretus, Hal.
tacitus, Hal.
exilis, Hal.
pallidipes, Wesm.
analis, Wesm.
vindex, Hal.
celsus, Hal.
crassipes, Wesm.
saevus, Hal.
instabilis, Wesm.
ochrogaster, Wesm.
compar, Marsh.
maculipes, Wesm.
cingulatus, Wesm.
irregularis, Wesm.
leptostigmus, Wesm.
parvulus, Wesm.
docilis, Hal.
nitidulator, Nees.
aethiops, Hal.
pactus, Hal.
aemulus, Hal.
zelotes, Marsh.
polyzonius, Wesm.
ruficeps, Wesm.
bajulus, Hal.
truncatus, Wesm.
rudis, Wesm.
caesus, Hal.
reconditor, Wesm.
caelatus, Hal.
testaceus, Wesm.
rufipes, Wesm.
comatus, Wesm.
fasciatus, Thoms.

* Mr. Claude Morley informs me that he has British examples in his collection.

† This species was not admitted by Marshall but has been included in his Palaearctic List by Szépligeti.

Group PETIOLARINI, Szépligeti.

Subfamily EUPHORINAE, Forster.

Streblocera, Westwood.
macroscarpa, Ruthe.
fulviceps, Westwood.
Harkeria, Cameron.
rufa, Cameron.
Perilitus, Nees.
brevicollis, Hal.
bicolor, Wesm.
= *basalis,* Curtis.
parcicornis, Ruthe.
secalis, Hal.
cerealium, Hal.
aethiops, Nees.
Syntretus, Forster.
conterminus, Nees.
splendidus, Marsh.
xanthocephalus, Marsh.
testaceus, Capron.
parvicornis, Rein.
vernalis, Wesm.
= *cultus,* Marsh.
cynthius, Lyle.
pusio, Marsh.
Wesmaelia, Forster.
cremasta, Marsh.
Eustalocerus, Forster.
clavicornis, Wesm.
Dinocampus, Forster.
rutilus, Nees.
strenuus, Marsh.
falciger, Ruthe.
terminatus, Nees
Euphorus, Nees.
mitis, Hal.
orchesiae, Curtis.
pallidipes, Curtis.
tuberculifer, Marsh.
picipes, Hal.
coactus, Marsh.
accinctus, Hal.
similis, Curtis.
intactus, Hal.
apicalis, Curtis.
ornatus, Marsh.
fulvipes, Curtis.
parvulus, Ruthe.

Subfamily METEORINAE, Marshall.

Meteorus, Haliday.
albiditarsus, Curtis. } *Zemiotes,* Forster.
caligatus, Haliday. } *Zemiotes,* Forster.
chrysophthalmus, Nees.
deceptor, Wesm.
pallidus, Nees.
tabidus, Wesm.
Meteorus, *continued.*
facialis, Ruthe.
ictericus, Nees.
pallidipes, Wesm.
confinis, Ruthe.
vexator, Hal.
obfuscatus, Nees.
punctiventris, Ruthe.
atrator, Curtis.
abdominator, Nees.
albicornis, Ruthe.
jaculator, Hal.
pulchricornis, Wesm.
niger, Lyle.
melanostictus, Capron.
consors, Ruthe.
scutellator, Nees.
var. *unicolor,* Wesm.
micropterus, Hal.
versicolor, Wesm.
bimaculatus, Wesm.
profligator, Hal.
filator, Hal.
delator, Hal.
brevipes, Wesm.
cinctellus, Nees.
tenellus, Marsh.
leviventris, Wesm.
rubens, Nees.
fragilis, Wesm.
luridus, Ruthe.

Group PACHYLOMMATINI, Szépligeti.

Subfamily PACHYLOMMATINAE, Forster.

Pachylomma, Brébisson.
buccatum, Bréb.
Spilomma, Morley.
falconivibrans, Morley.

Group FLEXILIVENTRINI, Haliday.

Subfamily APHIDIINAE, Forster.

Toxares, Haliday.
deltiger, Hal.
Ephedrus, Haliday.
validus, Hal.
lacertosus, Hal.
plagiator, Nees.
Monoctonus, Haliday.
nervosus, Hal.
paludum, Marsh.
caricis, Hal.
Praon, Haliday.
abjectus, Hal.
exoletus, Nees.
dorsalis, Hal.
longicornis, Marsh.
flavinodis, Hal.
volucris, Hal.
absynthii, Bignell.
lepelleyi, Waterston.
Coelonotus, Forster.
pictus, Hal.
pini, Hal.
laricis, Hal.
Aphidius, Nees.
ephippium, Hal.
longulus, Marsh.
infulatus, Hal.
abietis, Marsh.
urticae, Hal.
gregarius, Marsh.
rosae, Hal.
lonicerae, Marsh.
lutescens, Hal.
avenae, Hal.
ervi, Hal.
ulmi, Marsh.

Aphidius, *continued.*
pascuorum, Marsh.
pterocommae, Marsh.
granarius, Marsh.
crepidis, Hal.
= *tuberculatus*, Wesm.
pseudoplatini, Marsh.
= *constrictus*, Hal.
dissolutus, Hal.
sonchi, Marsh.
asteris, Hal.
ribis, Hal.
cirsii, Hal.
eglanteriae, Hal.
hortensis, Marsh.
chrysanthemi, Marsh.
matricariae, Hal.
arundinis, Hal.
cardui, Marsh.

Aphidius, *continued.*
salicis, Hal.
fumatus, Hal.
exiguus, Hal.
scabiosae, Marsh.
leucopterus, Hal.
brassicae, Hal.
fabarum, Marsh.
ambiguus, Hal.
dauci, Marsh.
polygoni, Marsh.
silenes, Marsh.
crithmi, Marsh.
absinthii, Marsh.
euphorbiae, Marsh.
lychnidis, Marsh.
cerasi, Marsh.
acalephae, Marsh.
callipteri, Marsh.

Aphidius, *continued.*
cancellatus, Buckton.*
constrictus, Nees.*
rapae, Curtis.*
Dyscritus, Marshall.
planiceps, Marsh.
Diaeretus, Forster.
leucopterus, Hal.
Trioxys, Haliday.
auctus, Hal.
brevicornis, Hal.
heraclei, Hal.
aceris, Hal.
betulae, Marsh.
centaureae, Hal.
angelicae, Hal.
minutus, Hal.
pallidus, Hal.
letifer, Hal.

Group EXODONTES, Marshall.

Subfamily Dacnusinae, Forster.

Symphya, Forster.
= **Oenone** Haliday.
hians, Nees.
mandibularis, Nees.
ringens, Hal.
Epimicta, Forster.
marginalis, Hal.
Liposcia, Forster.
discolor, Marsh.
Dacnusa, Haliday.
adducta, Hal.
phoenicura, Hal.
navicularis, Nees.
semirugosa, Hal.
talaris, Hal.
striatula, Hal.
tristis, Nees.
ampliator, Nees.
petiolata, Nees.
egregia, Marsh.
temula, Hal.
macrospila, Hal.
senilis, Nees.
nemesis, Morley.
naenia, Morley.
misella, Marsh.

Dacnusa, *continued.*
albipes, Hal.
apollyon, Morley.
lateralis, Hal.
cincta, Hal.
lepida, Marsh.
ovalis, Marsh.
leptogaster, Hal.
postica, Hal.
diremta, Hal.
lar, Morley.
gracilis, Nees.
aphanta, Marsh.
stramineipes, Hal. } *Rhizarcha*, Forster.
areolaris, Nees. }
alecto, Morley. } *Rhizarcha*, Forster.
nox, Morley. } *Rhizarcha*, Forster.
clandestina, Hal.
aquilegiae, Marsh.
abdita, Hal.
gilvipes, Hal.
Gyrocampa, Forster.
uliginosa, Hal.
affinis, Nees.
foveola, Hal.
Chorebus, Haliday.
nereidum, Hal.
limoniadum, Marsh.
lymphatus, Hal.

Chorebus, *continued.*
naiadum, Hal.
Chaenusa, Haliday.
conjungens, Nees.
Coelinius, Nees.
viduus, Curtis.
podagricus, Hal.
niger, Nees.
ruficollis, H.-S.
= *procerus*, Hal.
gracilis, Hal.
elegans, Hal.
fuliginosus, Curtis.*
Polemon, Giraud.
liparae, Giraud.
Chaenon, Curtis.
anceps, Curtis.

Subfamily Alysiinae, Forster.

Chasmodon, Haliday.
apterus, Nees.
Panerema, Forster.
inops, Marsh.
Aphaereta, Forster.
minuta, Nees.
= *cephalotes*, Hal.
debilitata, Morley.
major, Marsh.

* These species were not admitted by Marshall but were included by Szépligeti in his Palaearctic List.

Syncrasis, Forster.
fucicola, Hal.
fuscipes, Hal.
= *halidaii,* Forster.
Trachyusa, Ruthe.
aurora, Hal.
Pentapleura, Forster.
angustula, Hal.
fuliginosa, Hal.
pumilio, Nees.
Alloea, Haliday.
= **Lamardatha,** Cameron.
**contracta,* Hal.
= *L. testaceipes,* Cam.
Tanycarpa, Forster.
gracilicornis, Nees.
rufinotata, Hal.
ancilla, Hal.
Idiasta, Forster.
maritima, Hal.
nephele, Hal.
Cratospila, Forster.
circe, Hal.
Alysia, Latreille.
manducator, Panzer.
soror, Marshall.
rufidens, Nees.
loripes, Hal.
fuscipennis, Hal.
similis, Nees.
Alysia, *continued.*
mandibulator, Nees.
atra, Hal.
truncator, Nees.
tipulae, Scopoli.
sophia, Hal.
lucia, Hal.
incongrua, Nees.
lucicola, Hal.
Phaenocarpa, Forster.
pullata, Hal.
pegomyiae, Marsh.
punctigera, Hal.
tabida, Nees.
picinervis, Hal.
ruficeps, Nees.
testacea, Nees.
maria, Hal.
galatea, Hal.
eugenia, Hal.
conspurgator, Hal.
pratellae, Curtis.
nina, Hal.
runice, Hal.
flavipes, Hal.
livida, Hal.
†*pallida,* Curtis.
Adelura, Forster.
florimela, Hal.
rufiventris, Nees.
isabella, Hal.
Adelura, *continued.*
dictynna, Marsh.
apii, Curtis.
sylvia, Hal.
Mesocrina, Forster.
pugnatrix, Marsh.
venatrix, Marsh.
Prosapa, Forster.
speculum, Hal.
= *venusta,* Hal.
Orthostigma, Ratzeburg.
pumilum, Nees.
Anisocyrta, Forster.
perdita, Hal.
Aspilota, Forster.
ruficornis, Nees.
fulvicornis, Hal.
compressa, Hal.
concinna, Hal.
jaculans, Hal.
maculipes, Hal.
praecipua, Marsh.
fuscicornis, Hal.
nervosa, Hal.
insidiatrix, Marsh.
brevicornis, Nees.
curta, Marsh.
concolor, Nees.
= *distracta,* Nees.

* See 1909, Entomologist, **42**: 96.

† This species was not admitted by Marshall but was entered by Szépligeti in his Palaearctic List.

ON THE BIOLOGY OF SOME CEROPLATINAE AND MACROCERINAE (DIPTERA, MYCETOPHILIDAE)

By G. H. Mansbridge, M.A. (Cantab.) D.I.C.

(Department of Entomology, Imperial College of Science and Technology.)

WITH AN APPENDIX ON THE CHEMICAL NATURE OF THE WEB FLUID IN LARVAE OF CEROPLATINAE

By Harold W. Buston, Ph.D., B.Sc., A.R.C.S., D.I.C.

(Department of Biochemistry.)

[Read 7th December, 1932.]

With Fifteen Text-figures.

Introduction.

The attention of the writer was first drawn to the larvae of *Platyura* by the finding of small insects entangled in their webs. When it was noticed that the insects were quickly killed on coming into contact with the droplets in the webs, the aid of a Biochemist was sought, and Dr. H. W. Buston describes his results in the Appendix.

The following account is mainly devoted to the habits of the larvae. I have not succeeded in obtaining eggs or very young larvae. Although this account of the biology of these flies is very incomplete, the extraordinary habits of the larvae is considered sufficient excuse for this paper.

In general appearance the larvae of both sub-families are somewhat similar, and they may be generally recognised by their great length and their fragile and more or less transparent body. An irregular purplish pigmentation is often present, due to large cells which appear to be oenocytes. All the larvae have been found to build an elaborate and extensive web in which there are droplets of clear fluid. These web characters will help, in the field, to distinguish the Ceroplatinae and Macrocerinae from other rather similar Mycetophilid larvae (*Sciophila* spp., *Acnemia nitidicollis*, Mg., etc.), in which the web is a mass of very fine dry threads, very like the cocoon web of some spiders.

The larvae of the two sub-families show no very obvious differences. *Macrocera* may be distinguished from the Ceroplatinae by the rather more rounded and slightly shorter head capsule, which is more heavily chitinised in parts.

The larval habits of the three species, *Platyura nigricornis*, F., *P. fasciata*, Mg., and *P. discoloria*, Mg., have been recorded in some detail as I found these larvae very readily.

Platyura nigricornis, F., *P. fasciata*, Mg., and *P. discoloria*, Mg.

No constant differences, either in habit or structure, were found between the larvae of these three species, and they will be treated together.

The extended, full-grown larva (fig. 1) is about 28 mm. long and 1·25–1·5 mm. broad. The sides of the body, including the head capsule, are roughly parallel. There are twelve body segments and the head capsule, which is partly retracted

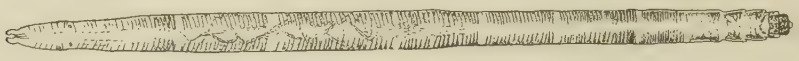
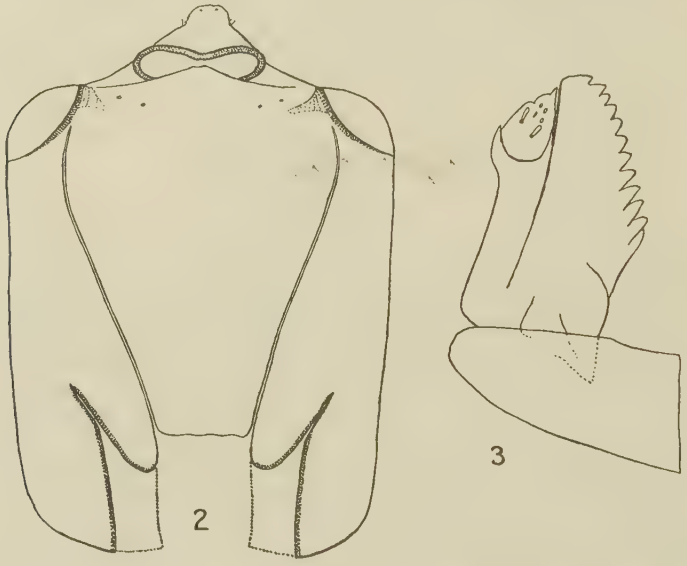


Fig. 1.—*Platyura* spp., full grown larva.

into the first segment. The first three segments are more distinct than those posteriorly. They are the shortest and about as long as broad, while those in the middle region of the abdomen are up to five times as long as broad.



Figs. 2–3.—*Platyura* spp.; fig. 2, head capsule, dorsal view; fig. 3, right mandible, ventral view.

Posteriorly the body is terminated by two papillae, which are probably used as feelers when the larva moves backwards in its web, as it often does. The abdominal segments have a number of transverse ridges which more or less

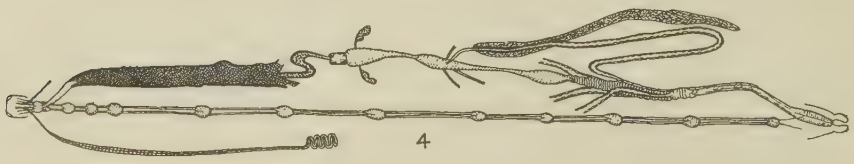


Fig. 4.—*Platyura* spp., alimentary canal and central nervous system.

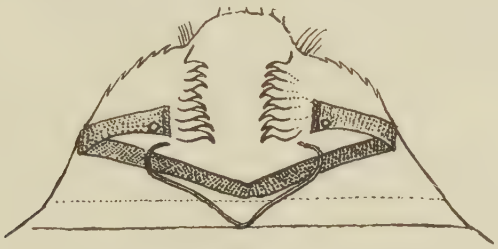
correspond to bands of purple pigment cells. On the sides of the abdominal segments the skin can be produced into sac-like protrusions. The anterior part of the last segment is pleated and this segment can be greatly distended. When distended it is often violently contracted and this movement drives the blood

of the body cavity forwards. A few tiny bristles were found—a pair on each anal papilla, two pairs on the sides of each thoracic segment, and several on the labrum.

A peculiar feature of the mouth is the labrum (fig. 5) which, with the epipharynx, is modified into a hood over the front of the mouth. This hood can be drawn down over the mouth-opening, which it then covers. Its ventral edges are continued into teeth. The posterior margin of the labrum is developed as a strongly chitinised hoop; this terminates in teeth ventrally, which are continuous with the more anterior teeth of the labrum proper. The use of the labrum is described in the account of the spinning of the web.

Goetghebuer (1926) points out that the teeth at the edges of the labrum in some Mycetophilid larvae may be modified premandibles, but in his specimens he could not find any articulation with the labrum, and according to him premandibles articulate with the labrum and have separate muscles. I carefully examined these teeth in *Platyura*, but found no articulation with the labrum or separate muscles.

The following account of these larvae is based on notes relating to about 860 individuals; I found larvae in over fifty different localities throughout



5

Fig. 5.—*Platyura* spp., labrum, ventral view.

eleven counties of South and South-East England. By far the greater number of larvae were in parklands and woodlands, of which Richmond Park may be taken as an example. Nearly all the remaining larvae were found on heathland areas—for example the low lying parts of Esher Common (Surrey)—in old birch or pine stumps, especially where the ground is poorly drained.

The larvae were found under the loose bark of large logs which had started to rot, and sometimes under the logs themselves, where these had become embedded in the soil. They were most plentiful in damp places, especially on a heavy and wet, humus or clay soil, while on well-drained light sandy soils only occasional larvae were found and then only in damp places. Most larvae were found in the logs and stumps of oak, ash and elm; but chiefly oak, for while the oak bark is still resistant and a good protection against drying influences, the outer part of the wood just beneath it rots, and shrinking away from the bark forms a suitable retreat for the larvae. The suitability of any log is largely dependent on its texture—the species and stage of decay—but the presence of sufficient moisture seems to be the main factor. In birch, horse-chestnut, beech and pine, no larvae were found except where the wood was very rotten and in a damp place.

The webs are seldom very close together and each larva has a distinct territory. The web is often built in situations where it is limited largely to one plane, in this case the full-sized web occupies an area of about 3 or 4 square

inches. In removing the bark the web is usually destroyed, and appears as an irregular slime surrounding the larva, actually it has a fine and elaborate structure. The greater part of it is formed of fine threads in which are suspended droplets of clear fluid, and any cavity near is often filled with a mass of this type of web. The droplets of the web are hygroscopic and their size varies to some extent with the moisture of the atmosphere. In the appendix it is shown that the droplets are very largely composed of N/30 oxalic acid. I have not been able to discover what part of the larva produces the acid or what part it plays in the metabolism. Running through the midst of the web is a thread rather stouter than the rest, and along which the larva can move with rapidity, and quickly get to any part of its territory. The web is often continued into some crevice of the log into which the larva may retreat, in many cases the old burrows of wood-boring insects are followed. Some larvae were found in oak logs only recently occupied by bark beetles, and the web was found to follow the mother and larval tunnels of these beetles, and to pass to the surface of the log through the " flight holes," and other openings to the exterior, the web being continued in the deep external fissures of the bark. When removed from its web the larva quickly dies, unless it is kept very moist. In the web the larva is apparently in the centre of the thread along which it moves, so that it is always enclosed in a fine layer of the thread-mucus.

The larva is long and mobile, and when turning round it doubles upon itself, the whole time keeping within the mucus of the thread and moving along its own ventral surface. The larvae move backwards in their web nearly as readily as they move forwards. In spinning the web the modified labrum (fig. 5) is used, and the thread appears to pass over its teeth. When attaching the thread the front part of the labrum is folded back, and the larva uses the heavily chitinised posterior margin, working this backwards and forwards for a moment at the point of attachment. The teeth of the labrum also, apparently, keep the thread taut in spinning. In building its web the larva first anchors its thread to a nearby object, and then attaches the other end to the thread enveloping its body. It then passes a second time over the threads, when it leaves droplets of clear fluid upon them at intervals. These droplets were seen to come from the mouth-parts of the larvae.

In the field the remains of the following prey have been found in the webs of *Platyura* spp.

Enchytraeus sp. (?*Fridericia* sp.) (Oligochaeta) 2 occasions.
(Myriapoda) 1 occasion.
Achorutes sp. (Collembola) 1 occasion.
(Collembola) 1 occasion, in great numbers.
(Coleoptera) 1 occasion.
Miastor sp. (larva) (Diptera) 1 occasion.
Cyclorraph larvae (Diptera) 2 occasions.

In the above list many of the records were from only just recognisable remains; in addition there were found a large number of quite unrecognisable remains—mostly small bits of chitin. In the laboratory the larvae disposed of their food fairly quickly, and this may account for the paucity of recognisable remains.

Larvae were sometimes found near masses of pink mycelium, and in a few cases a pink colour was seen in the gut. In one case in the laboratory a bright blue mould grew in one on the tin breeding-boxes on some white card. A larvae which had been starved for some months was feeding on this. I believe

these may be considered as exceptional cases, but the question of food will be referred to again.

Laboratory Methods.

Some larvae were kept in glass-topped tin boxes (3″ diameter by $\frac{3}{4}$″ high), the bottom of the box being covered by about $\frac{1}{4}$″ deep with cotton wool saturated with moisture. On this were placed 4 or 5 microscopic coverslips, under which the larvae would retreat on being alarmed. The inside of the glass lid was smeared with a thin layer of pure glycerine, which, while fresh, kept the larvae from attaching their threads to the lid. Two larvae were placed in each box.

Other larvae were kept in the same kind of tins, only on their original bark, as controls on the behaviour of those on cotton wool.

Again, other larvae were kept, with small strips of bark and decaying leaves, between two sheets of glass spaced $\frac{1}{4}$″ apart. This last method was an attempt to more closely imitate their natural haunts and yet keep them under observation.

In every case the larvae readily adopted their new surroundings (provided they were kept sufficiently moist), but it was a week before they had spun the usual amount of web, and not until this did they show the sure quickness of movement which is evident when they are accustomed to their surroundings.

These methods, with slight modifications, were also used for rearing the other species of the Ceroplatinae and Macrocerinae.

Laboratory Observations.

The larvae quickly responded to any movement in their web and have not been found to fail to attack anything alive and moving, from the larvae of large chafer beetles to small Collembola. But if a small bristle is moved in the web the larvae advance to examine it, and then take no more notice of it.

The following prey was offered and accepted, as well as the prey recorded from webs in the field :—

Larvae of *Piophila casei* (Diptera).
„ „ *Scolytus intricatus* (Coleoptera).
„ „ Scarabaeidae (Coleoptera, $\frac{1}{2}$″ long).
Anurida sp. (Collembola).
Free living Nematodes ($\frac{1}{4}$″ long).

Sometimes more than one prey was placed in the web at the same time, when the *Platyura*, having got one under control, went and secured the others in turn.

The method of attack varies with the type of prey, the larger requiring more complex treatment than the smaller creatures. The following observations on some different types of prey illustrate usual methods.

Observation 1.—A full grown larva of *Piophila casei* was placed in the thick of the web. This larva is muscular and active and has a tough chitinous cuticle. In bulk it is rather larger than the *Platyura*. The *Platyura* advanced, quickening its pace when the *Piophila* struggled. It attached a few threads to the larva, mostly to the anterior end, and then retired for a short time, when it was observed to traverse many different parts of its web, frequently pausing and making peculiar movements of its body—alternately contracting and expanding its segments. As the prey was active the *Platyura* was soon back again attaching other threads. By gently stirring the prey in the web, the

Platyura could quickly be brought back to it. It then tried to pierce the cuticle with its mandibles, but with *Piophila* it has not been observed to succeed.

Every now and again the *Platyura* ejected a clear fluid from its mouth region on to the surface of the *Piophila*, also as the *Piophila* struggled it came in contact with the clear droplets of the web which united with the fluid already on its body, and eventually it was completely enveloped in fluid. Before this occurred its activity was much lessened and soon ceased. While manipulating the *Piophila*, the *Platyura* moves as freely in the fluid on the surface of the prey, as in its own thread. After the *Piophila* was under control the *Platyura* dragged it to its lair, where it consumed it at leisure. If the prey is very large, so that it cannot easily be moved, the *Platyura* builds a mass of web around it, which is sometimes so thick that it hides the prey.

Observation 2.—An Oligochaete worm (ENCHYTRAEIDAE, 30 mm. long) was placed on one of the marginal threads of the web. The *Platyura* seized it firmly and dragged it quickly into the thick of the web, which was a distance of about two inches. In this process the thin sensitive cuticle of the Oligochaete took up the fluid of the web and in a few moments it ceased to struggle.

Observation 3.—The larvae appeared to treat larger and more lively Enchytraeid worms in a particular way, *e.g.* those about twice as large as themselves One case will serve as an example.

An Enchytraeid worm was placed in the web of a larva which had not fed for some days. At first it hesitated, then, as if realising what it was, it rushed forward with great speed, seized the worm firmly by the head, then bunching its body as if for great muscular effort, it dragged it over one inch, then releasing its hold on the head it drove his mandibles into a segment just behind. Then at the rate of about two bites a second, it treated every few segments in the same way, working backwards. The posterior quarter was left uninjured, and twisted about violently from the point where the most posterior bite was made; all in front of this was quite still and curled into an 8. The marks of each of the bites were seen as two punctures with the body tissues oozing out. Then the *Platyura* started to connect threads to it. These same methods were seen at many different times. In addition, sometimes, when the Enchytraeid was escaping a tug-o'-war took place, and several times the worm was seen torn in half at the point where the mandibles of the *Platyura* held it.

Observation 4.—A Collembolan was placed on one of the threads near the *Platyura*. It took a bite out of the back of the Collembolan and after about a dozen such mouthfuls the Collembolan had disappeared, and portions of it were seen passing down the alimentary canal.

Enchytraeid worms were kept with some of the larvae, in order to see how the *Platyura* caught its own prey. As the worms crawl about sooner or later they just touch the thread of the *Platyura* which rapidly moves to the origin of the movement, but by the time it arrives the worm has probably moved out of the range of the web, or it may be touching some of the other threads. After repeated tries the *Platyura* gets a hold on the worm, then with an exhibition of extraordinary muscular effort it drags it into the centre of the web. It seems likely that in nature most of the prey is dragged into the web in this way. Larvae of *Scolytus intricatus* were taken very readily by *Platyura*, even when about ten times its own bulk. These would be dragged into the web as with the other prey. In most cases the back of the *Scolytus* was torn open, and in one case the gut was found hanging in a long string from the opening.

In the laboratory cannibalism was the invariable result of overcrowding.

A space of 5 square inches was the least in which two larvae were ever kept without fighting, and then cannibalism often occurred. Fighting almost always ended in cannibalism, owing to the delicate nature of the larvae; even a slight injury was generally fatal. Usually the intruder was chased off at once, and may have had its posterior segments injured or even bitten off. When the intruder was much larger than the owner of the web, the owner usually kept at a safe distance. In one case a larva was seen vigorously and repeatedly jerking the part of its web which had been invaded by a large larva of the same species. The same action of jerking and vibrating the web was observed when the larva was tackling a very large and active prey. In some cases the larvae tried to rob adjacent webs of their prey.

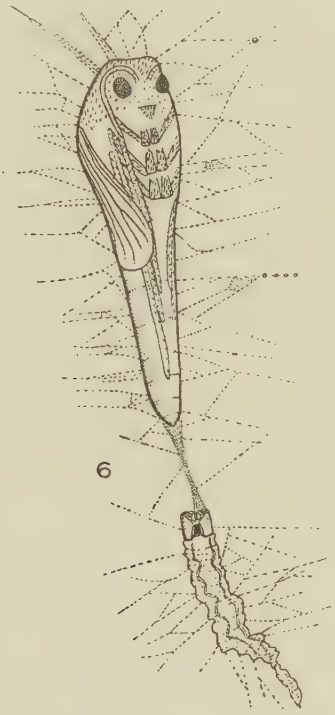


Fig. 6.—*Platyura* spp., pupa.

Larvae were found throughout the year, though they were not so numerous during the summer—June, July and August. Adults were first observed flying at the end of May. In the laboratory the first adults emerged at the end of April.

The first sign of pupation was in the appearance of two brown spots on the dorsal side of the first thoracic segment, just behind the head capsule. These spots, evidently rudimentary eyes, gradually deepen in colour up to the time of emergence. They were just recognisable about eight days before pupation. The next sign of pupation was in the marked shortening of the body and in the thickening of the thoracic region, which took place about one and a half days before actual pupation. During this time a few extra threads were spun around the pupating larva, these were of the normal web type and never so numerous as completely to hide the *Platyura* from view. After the shortening

of the body the larva remained in the same place, if undisturbed, and did not feed.

In pupation the skin of the larva splits along the dorsal part of the thorax, and the newly emerged pupa draws itself forward, leaving the old larval skin behind, with its tracheae, head capsule, etc. The whole action of pupation takes place within the tube-like structure of the main thread, as the surrounding threads of the web are attached to the main thread and not directly to the larva. This seems to explain the remark of Malloch (1917, p. 261): "How the larval skin can possibly be shed without detaching these threads, I cannot explain, but it is done."

The time of pupation from the casting of the larval skin until the emergence of the adult fly, took from six to ten days, usually eight days. During the first few days the pupae were of a very pale cream colour; this became slightly darker at about the fourth day. About two days before emergence there was a distinct change in that the chitinous parts became very much darker, spines, veins of the wings, etc., became prominent. A few hours before emergence a great extension of the legs took place, previously they did not reach the tip of the abdomen. If undisturbed on emergence the flies slipped about three-quarters out of the pupal skin, and were in some cases observed to remain like this for as long as three days without moving, then flying up at the slightest disturbance.

The pupal stage was found to be a critical period in the life-cycle. About half the pupae in the laboratory were attacked by fungus on pupation and died. Pupae which were disturbed or taken from their webs usually died. This last point has been mentioned by Edwards (1924, p. 548) in the pupa of another Mycetophilid (genus *Mycomyia*). In *Platyura* I suggest that the death of the pupa on removal from the web may be due to the pupa not being able to resist the acid of the web. If a pupa was removed it almost always touched droplets of the web fluid: in spite of the fact that the threads just around the pupa are cleared of droplets by the larva before pupation.

A number of larvae were reared to adults and the three species were found in the localities as follows:—

P. nigricornis—Kimberley Park (Norfolk); Ruislip (Middlesex); Iver (Bucks); Selsdon and Oxshott (Surrey).
P. fasciata—Ruislip; Epping Forest; Richmond Park.
P. discoloria—Ruislip.

Platyura pallida, Staeg.

About 20 larvae were found under boulders on Dartmoor, in April, at about 800 feet. Only one adult was bred, which emerged in June.

The web was similar to that of the other species of *Platyura*, and the larvae were seen to be predacious as in the other species.

These larvae appeared to be quite similar in structure to the other three species of *Platyura*, though they apparently differ in their habit of living under boulders. The larvae of *Platyura nemoralis* (*?*) and *Macrocera stigma* have also frequently been found in similar places. *P. nigricornis*, *P. fasciata* and *P. discoloria* have never been bred from under boulders, though carefully searched for.

Platyura sp.

Five larvae all apparently the same species were found among the roots of grass in a meadow at Wicklewood (Norfolk) in April 1930. Nothing remarkable

was noticed about the locality. They were about two inches below the surface under a level stretch of turf. In the laboratory the larvae spun webs similar to but smaller than the other observed species of *Platyura*, the same abundance of clear droplets was noticed. They responded to movement of their webs and attacked small Enchytraeid worms placed there. They were not seen eating, but this would be due to the fact that they were ready for pupation.

The full-grown larva was about 17 mm. long, and of the same proportions as the larvae of the other species of *Platyura*, which it closely resembled, but they were very white, being apparently without the purple pigment cells. The process of pupation and the suspension of the pupa was as in the other species, and also the general shape and behaviour of the pupa.

Other larvae similar to the above were found under boulders lying in turf at the Biological Field Station, Slough.

No adult was reared, but from the small size of the pupa and the similarity of the larva with the foregoing species of *Platyura*, these larvae may have been *Platyura nemoralis*, Mg., and this is supported by the fact that adults of *P. nemoralis* were shortly afterwards taken in the same locality.

Apemon marginata, Mg.

Only one larva was found and that in the New Forest in April under a small branch which had become half embedded in the turf. The soil was very wet. The web extended into the cavities of the turf and was very extensive and with very large droplets. The main thread of the web was slightly wider, in proportion, than that of *Platyura* spp., but not so wide as in *Ceroplatus lineatus*.

In the laboratory the larva spun a large web. It was most voracious and quickly killed and ate Enchytraeids its own size. The Enchytraeids appeared to die rather more quickly in the web of this larva than in the webs of *Platyura*, thus suggesting that the web fluid is more deadly in this species. The larva was about 40 mm. long and of the same proportion as *Platyura*.

The process of pupation and the pupa were much as in *Platyura*. The pupa was nearly obscured by a thick mass of web, but there was no definite cocoon. The shape and behaviour of the pupa were, as far as seen, similar to *Platyura*.

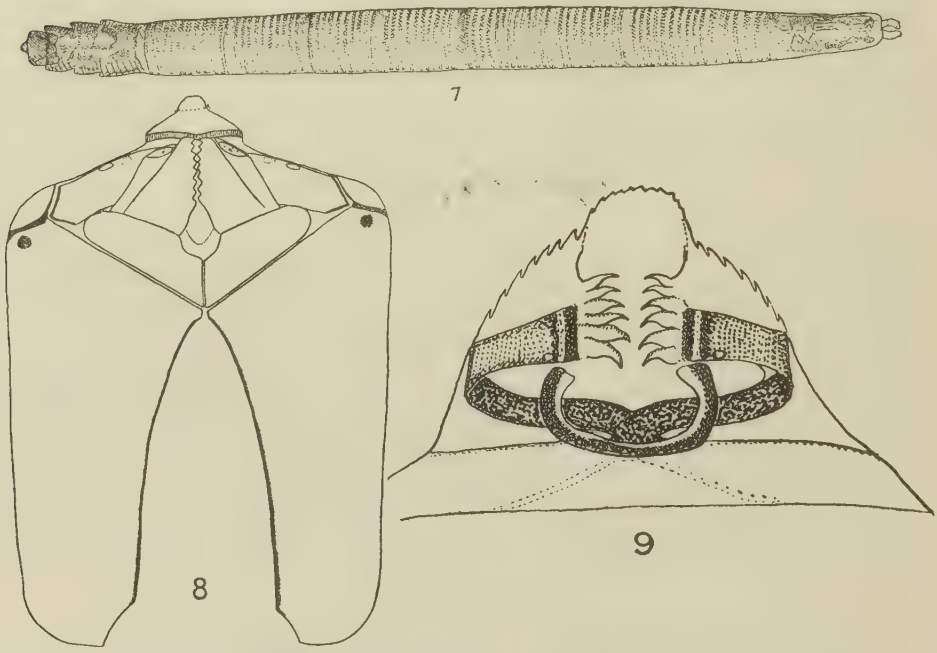
Ceroplatus lineatus, F.

The following observations are from about 150 larvae found in 14 different localities in the South and South-East of England. The larvae of this species have, on the whole, been found in more damp and less ventilated situations than the larvae of *Platyura*. They have been found most frequently in and under very rotten logs of various trees which have become destroyed by fungus and sodden with moisture. As with the three species of *Platyura* described above, these larvae have been taken chiefly in parklands and woodlands, but not nearly so abundantly as *Platyura*. Unlike *Platyura*, the larvae occur quite close together, and many have been found to share their webs to some extent. This is probably related to a less developed carnivorous habit in this species as compared with *Platyura*.

The web is very profuse and more noticeable than that of *Platyura*. It often fills considerable cavities in the rotten wood, and has been seen to occupy a space $6'' \times 1'' \times 1\frac{1}{2}''$. It further differs from *Platyura* in the larger web droplets, which are generally about 2 mm. in diameter, and often larger. In the midst of the web is a ribbon-like thread which is rather broader than the larva, through which the larva moves. In some cases the web has been found to

extend over a patch of mould as a complete transparent film, but which remains apparently detached from the mould, allowing the larva to move quite freely underneath. In one instance an unbroken film was found covering a mould of about 30 sq. cm.

On only two occasions were animals found caught in the webs of this species. There were three species :—*Trichoniscus pusillus*, Brandt. (Isopoda), *Porcellio scaber*, Latreille (?) (Isopoda) and Collembola sp. In neither case was there definite evidence of their being eaten. In experiments in the laboratory the larvae of *C. lineatus* were found to disregard small insects and Enchytraeid worms placed in their path, and even to avoid them. Two larvae in the laboratory lived quietly side by side in the same web for about five months, but



Figs. 7–9.—*Ceroplatus lineatus*, F.; fig. 7, full grown larva; fig. 8, head capsule, ventral view; fig. 9, labrum, ventral view.

when one pupated it was eaten by the other. The larvae were often observed feeding on moulds. They would feed readily on dead insect larvae, but they were never seen to attack anything moving and living of their own accord.

The adult larva (fig. 7) is about 30 mm. long and about 2 mm. in width, though some of the larvae pupated and produced adults when only about half this size. This larva is stouter than the larva of *Platyura*. The most obvious difference to any of the above-mentioned larvae of Ceroplatinae is the deep purplish colour which is due to the masses of pigment cells, about equally distributed all over the surface of the body. These cells are largely grouped in transverse bands, corresponding to the transverse ridges, but in the first three segments and in the last segment posteriorly their distribution is irregular. As in *Platyura*, anal papillae are present.

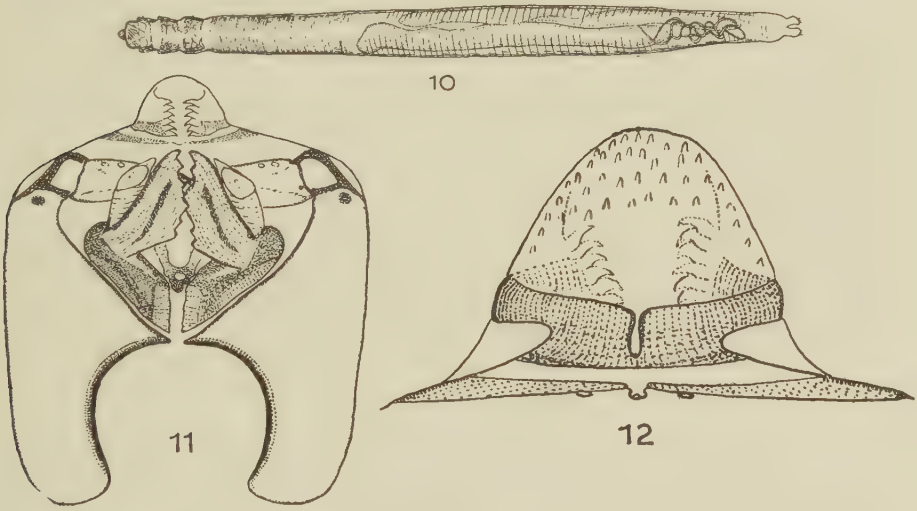
In at least three larvae parasitic grubs were seen, but no parasites were reared.

The pupation of this species is similar to that of *Platyura*. The web being dense, the pupae were generally hidden, but there was no cocoon. This species then differs from *Ceroplatus testaceus*, Dalm. (Edwards, 1924, p. 525), in which there is a definite, though thin, cocoon.

Pupation, in the laboratory, took about eleven days, the first adults emerged on June 11th, and they continued to emerge throughout June and July.

Macrocera stigma, Curt.

The larvae of this species were easily recognised by the large bright yellow fat bodies lying among the malpighian tubules in the posterior half of the body. The anterior part of the body and the last segment are moderately pigmented. Pigment cells are more or less scattered over the whole body. The head capsule is a darker brown and more rounded than in *Platyura*.



Figs. 10–12.—*Macrocera stigma*, Curt.; fig. 10, full grown larva; fig. 11, head capsule, ventral view; fig. 12, labrum, dorsal view.

The following observations are from about 70 larvae found in 11 different localities in the South and South-East of England. The larvae were found under logs and boulders which had been lying in the same place for some time, the webs spreading in the cavities and galleries in the soil immediately under these logs and boulders. All the larvae were found in woodlands where there was a heavy moisture-retaining soil.

On two occasions a small spider was found in the same web as the *Macrocera* larva. They lived together in the same web in the laboratory, and the spider was easily able to move about the *Macrocera* web without getting entangled, but I did not notice any special relationship between them.

As with *Platyura*, the *Macrocera* larvae were not found living very close together. The webs were found to extend two inches or more in length and to occupy about a cubic inch. The threads were finer than in the webs of *Platyura*, and the main central thread was of about the same thickness as the others. The droplets were of about the same size as in *Platyura*, though only about half as numerous.

All the larvae found quickly coiled into a ball on being alarmed, especially when their webs were jarred or torn.

The only thing, in the nature of prey, found in the webs of this species was an adult Chrysomelid beetle.

In the laboratory the *Macrocera* larvae killed and ate small Enchytraeids placed in their webs. Their methods were similar to *Platyura* already described, but they were not so quick and thorough in killing their prey. On contact with the web the Enchytraeids died about as quickly as in the case of *Platyura*, and death occurred in much the same way, which suggests that the webs of *Macrocera* also have poisonous properties.

The full-grown larva (fig. 10) is about 18 mm. long and about 1·5 mm. broad. The segments in the abdominal region are ridged transversely and there are two small anal papillae. The head capsule (fig. 11) is about as long as broad. The space between the ventral sclerites of the head is short and rounded. Eyes antennae and sensory pits are all present and are much the same as in *Platyura*. The labrum (fig. 12) differs from *Platyura* in the shape of the chitinised basal part, and it is papillated dorsally. It has been seen to close like a lid over the mouth-opening.

I have found this larva more or less commonly throughout the East and South-East of England.

Macrocera fasciata, Mg.

Two adults of this species were bred from pupae found under an elm log lying in long grass at Shardeloes, Bucks, August 30th, 1930. The log had become partly embedded in the turf so that the web in which the pupa was suspended penetrated the cavities of the ground under the log. These pupae bore no marked difference from those of *Platyura*.

Enslin (1906) found a larvae of *M. fasciata* in a cellar.

Macrocera vitatta, Mg.

One adult of this species was bred from a pupa found with the two pupae of *M. fasciata* under an elm log at Shardeloes, Bucks. This pupa was distinguishable from the others by a deep purple pigmentation.

Hymenopterous Parasites of *Platyura* and *Macrocera*.

Three different species of parasites were reared from the larvae of the three species of *Platyura* (*P. nigricornis*, *P. fasciata* and *P. discoloria*).

Belyta sp. (Belytidae).

The adults were reared from *Platyura* larvae from Kimberley Park and Hevingham Park in Norfolk, and Richmond Park and Leatherhead in Surrey. This parasite after removing the head capsule, pupated in the old larval skin of its host (fig. 13). Four males and three females were reared at ordinary room temperature. The males emerged at the end of January and the females about three weeks later. The pupal stage lasted about ten days. Emergence may have been hastened as the laboratory was rather warm. Adult parasites were kept in tins with larvae of *Platyura*, but no attempt at parasitism was seen. Unfortunately the males had all died by the time the first female had emerged. The adults, being heavily protected by chitin, were not troubled by the *Platyura* larvae, though the latter were observed to try and entrap them in their webs.

The adult parasites crawled about through the web, and apparently were not affected by the acid, though the web, being rather sticky, impeded them.

Dicolus insectator, Frst.(?) (Ichneumonidae).

Seven adults, all males, were reared from larvae from Kimberley Park (Norfolk), Leatherhead, Richmond Park and Oxshott Heath (Surrey), Fulmer (Bucks) and Cobham Park (Kent). The cocoon (fig. 14) was made of light brown silk and was suspended in the web of the host, with the skin and head capsule of *Platyura* near by.

Helictes mediator, Schiödte (Ichneumonidae).

One female only was reared from a larva taken in the New Forest. As with *D. insectator*, the head capsule was the most noticeable remains of the *Platyura*. The cocoon was of light brown silk and remained suspended in the web of the host.

Out of more than a hundred larvae of *Ceroplatus lineatus*, F., kept in the

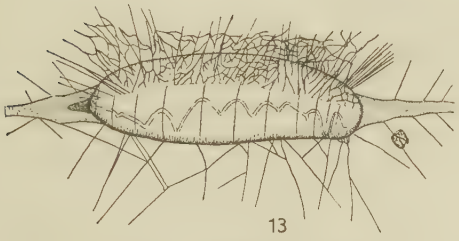


Fig. 13.—*Belyta* sp., pupa.

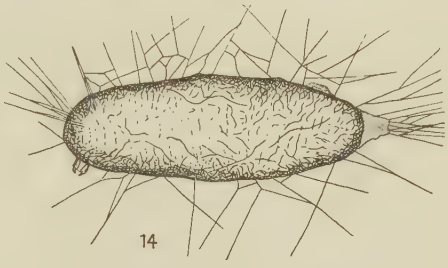


Fig. 14.—*Dicolus insectator*, Frst. (?).

laboratory, three were seen to contain parasitic grubs, but all three hosts died and no parasites were reared.

Four larvae of *Macrocera stigma*, Curt., out of more than fifty kept in the laboratory, were seen to contain parasitic grubs. One parasite was reared, *Dicolus hirticornis*, Strobl, a species hitherto not known from Britain, a female from Dunston Park (Norfolk). As in *D. insectator* which was reared from *Platyura*, there was a neat cocoon of light brown silk suspended in the web of its host. The head capsule of the host remained adhering to the outside of the cocoon. Unlike the cocoons of the other parasites reared, the walls of this cocoon were drawn in so as to form five or six flutings longitudinally, so that in transverse section it was not round but like a star with short, thick rays.

Other Hymenopterous parasites of Mycetophilids have been described by Dr. A. Roman (1923).

The Carnivorous Habit in Mycetophilid Larvae.

There are various records of a carnivorous tendency among the larvae of this family (see below), but that some larvae feed on insects caught in their webs has scarcely been recognised, though recorded by Norris (1894) in *Arachnocampa luminosa* and by F. X. Williams (1915) in *Bolitophila luminosa*. On the other hand, the larvae of *Platyura marginata* and *P. latricornis* have been recorded from fungi (Osten-Sacken, 1862), and Edwards (1924) mentions that *Platyura* larvae are thought to feed on fungal spores.

In confirmation of the carnivorous habit of *Platyura* larvae and related species there are the following facts :—

1. The shape of the mandibles is very different from the rasping type of fungivorous Mycetophilid larvae.

2. The behaviour differs from the fungivorous Mycetophilids, in that they are very active and their reactions are quick. In *Ceroplatus lineatus* the reactions of the larvae are not so quick as in *Platyura*, which may be related to the less developed carnivorous habit.

3. The larvae are solitary, unlike many other Mycetophilid larvae.

4. The web fluid kills other insects. In *Ceroplatus* it is not so deadly as in *Platyura*, which may be related to the more highly developed carnivorous habit in *Platyura*.

From the above it is seen that the carnivorous habit is present in at least

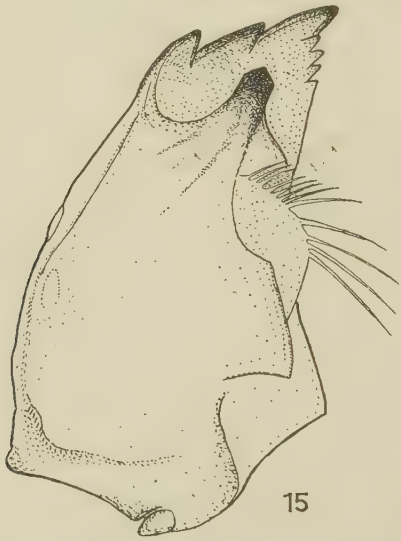


Fig. 15.—*Platyura* spp., left mandible.

three sub-families of the Mycetophilidae (Ceroplatinae, Macrocerinae and Bolitophilinae), and from the following records it will be seen that there are at least tendencies in that direction among other groups of the family.

Norris (1894) in describing the habits of *Arachnocampa luminosa* (the New Zealand Glow-worm) relates how the larva spins its web on rock surfaces; and he suggests that insects may be attracted into it by the light of the larva. He records the remains of Diptera, Coleoptera, Lepidoptera and many Crustacea in the webs. He has further observed the larvae smothering live insects with mucus, and he gives an account of a larva eating a Crustacean.

Cheetham (1920) records the larva of *Polylepta leptogaster* as spinning their webs over rock surfaces where there was practically no organic matter. Hungerford (1916) records the larvae of *Sciara coprophila* feeding on the dead bodies of adults and pupae of their own kind. Jones (1920) records the larvae of *Neosciara macfarlanei* feeding in the overloaded pitchers of pitcher plants (*Sarracenia*), there being three to twelve or more in a single pitcher. Malloch (1917, p. 259) records larvae of *Sciara* sp. feeding on grubs killed by fungi or bacteria.

With regard to carnivorous tendencies among species of *Sciara* it is interest-

ing to note that the mandibles of the larvae are square and lack the rounded rasping edge of many of the fungivorous forms, though they are not so pointed as in *Platyura*.

A careful study of the habits of Mycetophilid larvae, with the morphology of the mouth-parts, the behaviour, and the nature of the web fluid, would be of great interest, especially in those larvae with carnivorous tendencies.

Luminosity was carefully looked for in all the species of Mycetophilid larvae kept, but in no case was it seen. In three separate cases luminosity was seen to proceed from the wood surrounding the webs of *Platyura* larvae, this was apparently due to luminous bacteria.

Platyura larvae were found to live, apparently without discomfort, in oxalic acid of the same strength as their web droplets (N/30). 5% Acetic acid had no immediate effect upon them. In HCl, though certainly toxic, the larvae lived in a 1% (N/35) solution for 15 hours, after which death occurred. Larvae were in N/4 HCl for three hours, and they lived afterwards apparently unaffected; though in the same HCl solution a small *Exechia* larva died in two to three minutes. These experiments are obviously rough, but I think they indicate a line of work which would prove interesting.

Summary.

The larvae of *Platyura nigricornis*, *P. fasciata*, *P. discoloria* and *Apemon marginata* were found to be predacious, catching prey by entangling them in their webs.

The droplets of fluid in the webs of *P. nigricornis*, *P. fasciata*, *P. discoloria* and *Ceroplatus lineatus* were shown to contain oxalic acid, of sufficient strength to kill insects coming in contact with it. The larvae of *Platyura* are immune to oxalic acid and they are remarkably resistant to other acids.

Macrocera stigma also showed carnivorous habits.

Four different species of Hymenopterous parasites were bred from the larvae of *Platyura* and *Macrocera stigma*.

Acknowledgements.

I am indebted to Professor J. W. Munro for his advice and encouragement all through this work, and to Mr. O. W. Richards for his encouragement to complete writing it up. I have to thank Dr. F. W. Edwards for his generosity in giving me much help from his unique knowledge of the Mycetophilidae, and also for identifying many adults. Dr. S. Madwar kindly allowed me to examine much of his unpublished work on the anatomy of Mycetophilid larvae. Dr. A. Roman of Stockholm kindly identified several Hymenopterous parasites, and I am indebted to members of the British Museum staff for various identifications. I also wish to thank Dr. H. W. Buston for his co-operation in this work.

References.

Cheetham, C. A., 1920, "*Polylepta leptogaster*, Winn., A cave-dwelling Dipterous larva in Yorks." Naturalist. **45 :** 189.

Edwards, F. W., 1924, "British Fungus Gnats," Trans. Ent. Soc. Lond., **1924 :** 505–670. 12 pls.

Enslin, E., 1906, "Die Lebensweise der Larve von *Macrocera fasciata*, Meig.," Z. wiss. InsektBiol., **2 :** 251–253.

Glaser, R. W., 1912, "The Oenocytes of Insects," Biol. Bull., Woods Hole, **23.**

Goetghebuer, M., 1924, "Prémandibules chez les Némocères," Encyclop. Ent. Diptera, **1 :** 143–157.
Hungerford, H. B., 1916, "*Sciara* maggots injurious to potted plants," J. Econ. Ent., **9 :** 538–549. 2 pls.
Imms, A. D., 1908, "Larval and pupal stages of *Anopheles maculipennis*, Mg.," Parasitology, **1 :** 103–133. 2 pls.
Jones, F. M., 1920, "Another pitcher-plant insect, *Neosciara macfarlanei*," Ent. News, Philad., **31 :** 91–94. 1 pl.
Malloch, J. R., 1917, "Key to larvae of Diptera," Bull. Illinois Lab. Nat. Hist., **12 :** 161–409. 29 pls.
Norris, A., 1894, "Observations on the New Zealand Glow-worm, *Bolitophila luminosa*," Ent. Mon. Mag., **30 :** 202–203.
Osten-Sacken, C. R., 1862, "Characters of the larvae of Mycetophilidae," Proc. Ent. Soc. Philad., **17 :** 151–171.
Roman, A., 1923, "Ichneumonids reared from Diptera Nematocera," Ent. Mon. Mag., **59 :** 71–76.
Tiegs, O. W., 1922, "Researches on the Insect Metamorphosis," Trans. Roy. Soc. S. Austr., **46 :** 319–528. 15 pls.
Wheeler, W. M., 1931, "Demons of the Dust," 8vo. London.

Appendix.

Note on the Chemical Nature of the Fluid from the Webs of Larvae of *Platyura* and *Ceroplatus*.

By Harold W. Buston, Ph.D.

Fluid was collected from the webs of *Platyura nigricornis*, F., *P. fasciata*, Mg., *P. discoloria*, Mg., and *Ceroplatus lineatus*, F. The fluid from the three species of *Platyura* was mixed, as no method was available for distinguishing these larvae, but from a number of samples of fluid taken from batches of larvae in which different species predominated, no variation was noticed.

The fluid was separated from the threads by gathering the web at the end of a fine glass rod; the droplets then ran together and drained away from the tangled threads.

As taken from the web the fluid was colourless and perfectly clear. The amount available was about 0·5 c.c. in all. The reaction of the liquid was strongly acid to litmus.

Platyura nigricornis, *P. fasciata*, and *P. discoloria*.

(1) Nature of acid.

The acidity of the fluid was roughly estimated by means of the capillator, and was found to be of the order p_H 1·8. Tests were made to determine the nature of the acid present, and this was finally identified as oxalic acid. The tests on which this identification was based were: (*a*) formation of white insoluble silver salt, not reduced on warming; (*b*) formation of insoluble calcium salt, insoluble in dilute acetic acid; (*c*) reduction of acid permanganate on warming; (*d*) microscopic form of crystals of calcium salt, ammonium salt, and free acid, compared with similar preparations from pure oxalic acid.

Tests were made for other acids possibly present, especially formic acid, but no other acid was detected. It appeared therefore that the acidity of the fluid was due entirely to oxalic acid. To give a solution of p_H 1·8 would require an N/30 (0·15%) solution of oxalic acid (approximately).

The identification of the acid in the web fluid as oxalic acid was entirely unexpected, since oxalic acid, while of common occurrence in plants, is by no means a typical product of animal metabolism.*

(2) Proteoclastic enzymes.

Prey caught in the webs of *Platyura* appeared to disintegrate, thus suggesting the possibility of some peptic activity on the part of the fluid. It was also noticed that a minute piece of freshly prepared coagulated egg-white placed in a drop of the fluid became smaller. Peptic activity was tested for by a modified Hata method, the substrate being adjusted to p_H 1·8 with oxalic acid. No peptic activity could be detected, although the digestion was continued for 48 hours. In a control experiment, 10 c.c. of the same egg-white suspension, treated with 0·5 mgm. of pepsin scales became clear in two hours. It was concluded therefore that the web fluid had no peptic activity. The suggestion is made that the shrinkage of egg-white originally observed may be accounted for by osmotic effects.

(3) Other substances.

Although the fluid dried readily on a glass slide, depositing microscopic crystals, these crystals were not so perfect in form as those obtained by drying a 0·2% solution of oxalic acid, but were surrounded by a thin amorphous film. This was probably due to the fact that the web contained traces of mucin or gum, probably derived from contact with the threads. The amount of fluid available was too small to allow of any further tests on this point.

Ceroplatus lineatus.

The web fluid of this species was also tested and was found to be similar to that of the above species of *Platyura*; the concentration of oxalic acid was, however, considerably less, the solution being about N/100.

The conclusion reached as to the chemical nature of the web fluids of these larvae was that the fluid consisted essentially of weak solutions of oxalic acid, approximately N/30 in the case of *Platyura*, N/100 in the case of *Ceroplatus*; that no other organic acid was present, nor any proteoclastic enzyme.

Experiments on an Oligochaete.

A series of experiments was performed to ascertain the comparative effect of the web fluid and of weak oxalic acid solutions on *Fridericia striata*, Levinsen (Oligochaeta). N/30 oxalic acid was used and was found to produce death in about 15 seconds. To ascertain whether this toxicity in the case of *Fridericia* was due to osmotic pressure effects, a solution of sucrose, isotonic with N/30 oxalic acid, was tested on the Oligochaete. This was found to be entirely non-toxic. Tests were also made using solutions of tartaric acid p_H 1·8. Results with this acid were irregular, but it was apparently rather more toxic than oxalic acid. It seemed possible therefore that both the H ion and the acid ion were partly responsible for the toxicity; it should be noted, however, that tartaric acid of p_H 1·8 is considerably more concentrated than oxalic acid of the same p_H, so that any increased toxicity may have been due to osmotic effects.

* Minute amounts of oxalic acid have been detected in the urine of mammals, particularly after the administration of large doses of glycerine; the amount present normally is infinitesimal.

The toxic effect of oxalic acid in the case of *Fridericia* was so marked, that it seemed of interest to examine the effect of pure oxalic acid on *Platyura* itself. It was found that *Platyura* could remain in contact with N/25 oxalic acid for at least four hours and retain unimpaired activity.

Note on the effect of oxalic acid on Fridericia striata.

A swelling of the genital organs was noticed in some cases, with a constriction of the adjacent parts; in a few cases actual rupture occurred. If the genital organs resemble those of higher animals in containing, at certain stages, large amounts of basic proteins, this effect is explainable on an osmotic basis—that the acid gives rise to a dissociable salt of the protein, with consequent increase of osmotic pressure inside the genital organs. This suggestion assumes, of course, that the epidermis of the genital organs is permeable to ions such as H, –COO, etc. No information was available, however, on the chemical nature of the contents of the genital organs of this Oligochaete, nor upon the question of the permeability of the epidermis.

TWO NEW MALAYAN SPHECOIDS

By H. T. Pagden, M.A.

With Six Text-figures.

[Read 7th December, 1932.]

Passaloecus (Polemistus) barabbas, sp. n.

Black. *Head* and *thorax* heavily sculptured, dull. *Face* deeply excavated and bearing a spine in the excavation. *Antennae* short. *Head* large, quadrate, wider than thorax. *Thorax* about as long as abdomen. *Abdomen* polished and shining, ovate in the female, widest across the second tergite and narrowing rapidly to the apex which is acute, in the

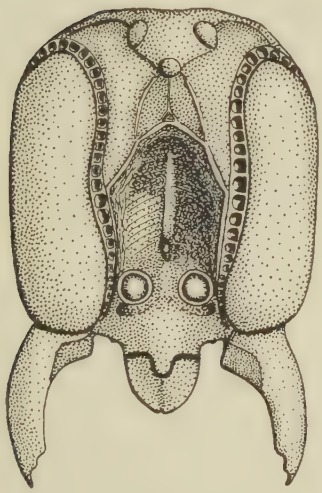


Fig. 1.

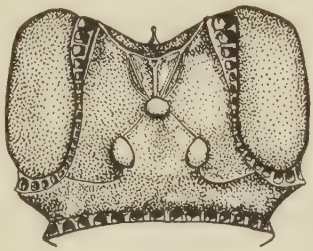


Fig. 2.

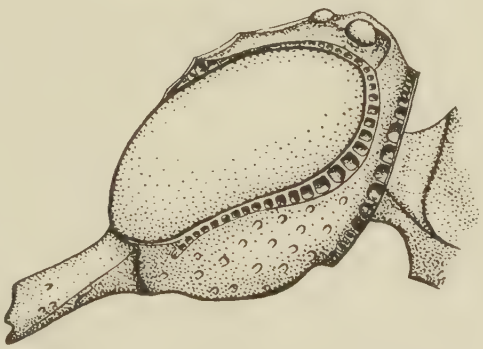


Fig. 3.

Fig. 1, *Passaloecus* (*Polemistus*) *barabbas*. Front view of head of female with antennae deleted; fig. 2, *P.* (*P.*) *barabbas*. Dorsal view of head of female with antennae deleted; fig. 3, *P.* (*P.*) *barabbas*. Lateral view of head of female with antennae deleted.

male it is more fusiform and strongly compressed laterally. *Legs*, tips of mandibles, scape and first two flagellar segments, the remainder beneath, and tegulae all more or less marked with ferruginous to ochreous. *Stigma* ochreous anteriorly, piceous posteriorly, wing-veins ochreous. Prothoracic tubercles pale yellow. ♂ smaller and more slender than ♀.

Length, 4·5 to 5·5 mm.

♀. *Head* massive, nearly square, but slightly wider than long, in dorsal aspect, face

rectangular, longer than wide, sub-rhomboidal in lateral aspect. *Eyes* very large, their inner margins sinuate. *Antennae* short, only a little longer than the maximum width of the head. *Clypeus* with a strong median and two small lateral teeth, the outer one very minute. *Labrum* large and prominent, sub-triangular, its sides strongly curved, its apex microscopically emarginate, its surface concave. *Mandibles* very large and robust, with three teeth. *Frons* deeply excavated and bearing a minute spine, constricted in the middle, situated on the median line about one-fifth of the distance from the antennal insertions to the brow of the excavation.

Sculpture of *head* complex. There is a strong circumoccipital carina, strongly costate anteriorly, the costae enclosing deep pits. Frontal excavation polished and transversely striate in the middle where there is a median carina commencing at the base of the brow and extending to the frontal spine, with which it is confluent. The brow and sides of the excavation with numerous concentric striae, which meet and separate again enclosing microscopic fusiform polished areas. Frontal spine, seen from above, constricted near its middle. The whole excavation bounded dorsally and laterally by a strong carina which, on the lower half, becomes the circumocular carina. The upper portion is 6-angled, including the angles it forms at its junction with the circumocular carina, each angle being at the point of confluence of another carina. These carinae are a median, extending from the anterior ocellus and branching just before its junction with the frontal carina so that the two arms, with the upper, transverse, portion of the frontal carina enclose a minute equilateral triangle, and a pair of fronto-lateral carinae which diverge from the median ocellus, where they are faint, and join the arch of the frontal carina about halfway between the median junction and the circumocular-frontal junction.

The *ocelli* are large and situated at the angles of a distinct prominence, their optical axes divergent, the lateral ocelli further apart than their distance from the eyes. There is a ridge running in a curve from the post-lateral margin of each lateral ocellus to the circumocular carina, joining it on the vertex and formed by a backward and lateral continuation of the ocellar eminence. Circumocular carina (not complete round the base of the eyes) with strong costae extending from its inner margin to the margin of the eye, the spaces thus enclosed deeply excavate, polished and shining.

Occiput microscopically punctate, genae and gula coarsely punctured, remotely on the genae, more densely on the gula, the surface between the punctures microscopically shagreened.

Clypeus with a strong median production and two small lateral teeth, the outer one very minute. Labrum porrect, very prominent, sub-triangular, its sides strongly curved, microscopically emarginate at the apex, its surface dull, concave, the whole almost like the bowl of a spoon. Mandibles robust, tridentate apically, dull, with a few scattered punctures and faint longitudinal striae, externally strongly convex, slightly concave internally. Labial palpi 6-jointed, maxillary palpi 4-jointed. Scape of antennae about $\frac{4}{9}$ as long as the flagellum, first flagellar segment pedicellate, narrow at the base and swollen apically, remaining segments gradually increasing in length from base to apex.

Thorax very coarsely sculptured, the surface shagreened between the major sculpturation.*

Pronotum shining on its anterior declivity which has the surface aciculate; its dorsal margin carinate, pitted behind, the lateral angles sharp; its lateral surface with a line of deep polished pits extending from the middle of the anterior lateral margin to the middle of the ventral margin, the anterior portion thus demarcated with a few longitudinal striae in the dorsal angle and vertical striae along the ventral margin, the surface rough and dull, the posterior portion with longitudinal costae in its concavity, the spaces between the

* The direction of all impressions and sculptural features is given with reference to the long axis of the insect.

costae pitted, the posterior convexity finely longitudinally striate as far as the tubercle, which is shining, its surface finely aciculate.

Mesonotum with its anterior slope coarsely reticulate, deeply pitted on the brow, the pits angular and more or less regularly arranged so that the declivity is crossed by longitudinal ridges. Lateral angles with large, deep, angular pits. The dorsal surface with eight rows of large pits, the median and third pair of rows reaching the posterior margin, the second and lateral not extending so far, the lateral row in a curve. Each row bounded inwardly by a ridge which is continuous with those crossing the anterior declivity. The postero-lateral margin, above the tegulae, bounded by a deep costate impression, polished and shining within, the outer margin carinate. Scutellum divided from the scutum of the mesothorax by a deep transverse furrow, divided by a median costa, the lateral portions each crossed by a smaller costa. The surface of the scutellum dull, shagreened, coarsely punctate, the punctures along its posterior margin confluent with the meso-metanotal

Fig. 4.

Fig. 5.

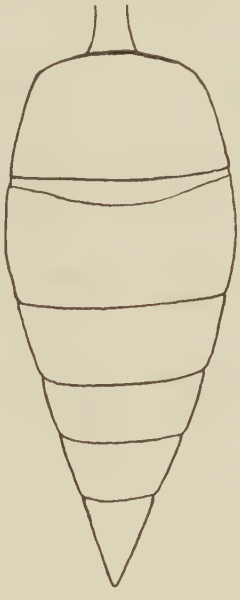


Fig. 6.

Fig. 4, *Passaloecus* (*Polemistus*) *barabbas*. Dorsal view of thorax of female; fig. 5, *P.* (*P.*) *barabbas*. Outline of dorsal aspect of abdomen of male; fig. 6, *P.* (*P.*) *barabbas*. Outline of dorsal aspect of abdomen of female.

suture giving it a crenate appearance. Laterally deeply excavate, polished and shining, longitudinally striate with the excavation.

Metanotum with a few large punctures dorsally, its surface dull and shagreened, somewhat wrinkled longitudinally; a deep polished fovea laterally followed by a flat, obliquely striate area which is steeply recessed towards the articulation of the posterior wings.

Propodeon shining, very coarsely clathrate, the apical excavation hexagonal, bounded by a strong carina, with a median furrow within the excavation and with transverse, divergent striae extending from the furrow to the surrounding carina. The declivity receding, coarsely clathrate, obscured by the brow from above.

Propleura anteriorly concave, polished and shining, microscopically punctured, bounded by a crenate carina posteriorly; clathrate ventrally; laterally dull, aciculate.

Prepectus of *mesothorax* anteriorly carinate, with a row of deep pits along the carina

posteriorly, the surface shagreened, with a few large punctures. Prepectal suture wide above, narrowing ventrally, strongly pitted. Mesepisternum large, convex, with a median pit, its surface shagreened, and bearing scattered punctures, crossed by a longitudinal crenate impression on the ventral $\frac{1}{3}$, its posterior angle above the articulation of the leg with some oblique rugulosity. Pleural suture crenate. Mesepimeron small, shining. Meso-metapleural suture crossed by strong costae which are continued onto the metapleuron. Propodeon laterally, where it joins the metapleuron, obliquely striate, the striae merging into the reticulation on the posterior $\frac{2}{3}$.

Abdomen broadest across the second tergite, not as wide as thorax, tapering rapidly to the apex. Impunctate, polished and shining. Petiole dull, transversely rugulose and medially furrowed above.

Pubescence and colour. Head black, scape of antennae and 1st and 2nd joints of flagellum reddish ochreous, the remaining joints tinged with the same colour beneath, piceous above. Mandibles with their apices dark ferruginous. Labrum piceous. Labial and maxillary palpi ochreous.

Front and intermediate legs with the apex of the coxae, base and apex of trochanters, and base of femora ferruginous; apex of femora and the whole of the tibiae and tarsi reddish ochreous. Hind legs with the femora almost entirely black, tibiae reddish ochreous with a fuscous cloud externally, tarsi reddish ochreous.

Tegulae ochreous. *Wings* clear hyaline, exhibiting considerable iridescence in some positions. Wing-veins ochreous, stigma ochreous on the costal margin, darker, almost piceous on the posterior half. Prothoracic tubercles pale yellow.

Clypeus clothed with silver pubescence, mandibles with a few aureo-griseous hairs, and a few hairs of the same colour at the apex of the labrum. Genae and gula with a sparse covering of short, argenteous pubescence. Prothoracic tubercles margined posteriorly with a narrow line of short silvery pile. A few minute silvery hairs on the black parts of the legs, those on the tibiae and tarsi inclined to pale golden. Abdomen with a sparse covering of minute argenteo-griseous hairs and bearing a few longer, more golden hairs at the apex beneath.

Wings with five hamuli.

♂ smaller than the ♀ from which it differs in the following points. Clypeus more densely covered with silvery pubescence. Labrum without any indication of an emargination at its apex. The thorax, for its size, is much more coarsely sculptured than in the female, the punctures on the scutellum almost running into reticulation; it is also rather more shining. The abdomen is fusiform, strongly laterally compressed, very convex dorsally and ventrally, flattened laterally. Aculeus of abdomen ferruginous, its apex darker.

Type ♀. Federated Malay States: Perak, Parit Buntar, 10.xii.1931.

Allotype from the same locality 4.i.1932.

Paratypes. 2 ♂♂, Sĕlayang, Sĕlangor, on *Citrus* 12.x.1929. Straits Settlements: Province Wellesley, 1 ♀ Butterworth, 24.ii.1930. F.M.S.: Perak, 1 ♀ Parit Buntar, 6.xii.1931, and 2 ♀♀ Parit Buntar, 7.xii.1931.

Type and allotype in Coll. British Museum. Paratypes in my own collection.

The puncturation of the scutellum varies slightly, being closer in some specimens than in others. The tarsi, especially the hind ones, are often dusky on their distal half.

Habits.

The habits are peculiar and were found out more or less accidentally. The first specimens captured, two males, were found on *Citrus*, where they were evidently feeding on the honey dew from numerous Aphids. Subsequently a

female, which I believed to be the same species, was found apparently collecting cerumen in the nest of a small black species of *Trigona* which had nested in a jalousie in a house at Butterworth. Further knowledge of the habits of this species was gained at Parit Buntar, where I found it nesting in my house in 1931 and 1932.

The nest is constructed in holes in wood. I have found them in the cavities over the heads of sunken nails in the weatherboarding outside my kitchen and in small holes left by Scolytids in the door of my garage and verandah gate.

The partitions between the cells and the plug closing the completed nest are made with cerumen taken from the nest of *Trigona* sp. The prey consists of Aphids. Specimens of the prey submitted to Mr. A. W. McKenny Hughes of the British Museum (Natural History) were kindly identified by him as *Aphis laburni*, Kalt., the carrier of bunchy top in ground-nuts.

The habit of robbing the nests of bees of the genus *Trigona* is, as far as I know, unique. Although the bees in the nest which I observed did not appear to take any notice of the *Polemistus*, the wasp is evidently particularly well suited to its mode of obtaining building materials. The integument is very hard and the antennae can be almost completely concealed in the frontal excavation. The abdomen is smooth and shining and would afford little purchase for the mandibles of the *Trigona*.

When hunting its prey, the insect usually flies up to the plant and settles on a leaf where it rests for a few moments. It then makes another flight and settles on a shoot, or the underside of a leaf where the Aphids are numerous; in the latter case it may simply walk round the leaf on which it originally settled. The prey is selected in quite a leisurely manner, a number of specimens sometimes being examined before one is taken. Usually an apterous female is chosen, sometimes a well grown nymph, but never a winged form so far as I could observe. The prey is seized by the thorax and dragged off the plant, the wasp immediately taking to flight and circling round the plant two or three times, occasionally settling on a leaf, sometimes flying straight back to its nest without settling until it reaches the entrance, when it goes inside without delay. I have not observed the insect sting its prey, possibly the pressure of the mandibles is sufficient to cause paralysis or death.

The above observations were made on a plant of *Crotalaria saltiana* (= *striata*) growing just outside the verandah of my house in Parit Buntar.

The situation of the nests made it impracticable to open them up for examination, so that I cannot say how many cells are constructed nor the number of prey stored in a single cell.

Bordage (1912, *Bull. Sci. Fr. Belg.*, **46**: 84) records *Polemistus dorsalis*, Kohl, from Réunion, as preying on small spiders of the genus *Attus*. He states that the specimens captured were very young, comparable in size to Aphids. The divisions between the cells of this species are constructed of mud.

Psenulus sogatophagus, sp. n.

A small black species, the integument shining. In the male the head is about as wide as the thorax between the wings, wider in the female. The head and thorax of the male are not quite as long as the abdomen without the petiole, as long in the female. The mandibles, scape, prothoracic tubercles, legs and sometimes the pronotal collar, scutellum and post scutellum, with flavous markings. Pubescence of face and legs silvery, of thorax argenteo-griseous more griseous on the abdomen.

Length, 7·5 to 8·5 mm.

♂. Head polished and shining with pruinose reflections, finely punctured, more closely

on the frons above the antennal insertion and behind the ocelli. Occipital carina finely crenate. Frons and clypeus beneath the pubescence densely, minutely punctate. Clypeus simply emarginate laterally, the median half produced, transverse, dull and impunctate. Frontal carina in the form of an inverted Y with curved arms.

Labrum with its margin shallowly emarginate. Mandibles bidentate apically.

Antennae: scape short, about as long as the third flagellar segment, minutely punctate dorsally. First flagellar segment shining, the rest dull, aciculate. The flagellum not thickened towards the apex. Comparative lengths of antennal segments:

Scape	2	3	4	5	6	7	8	9	10	11	12	13
1·25	0·5	1·75	1·25	1·25	1·25	1·25	1·25	1·25	1·25	1·25	1·25	1·5

Ocelli in a triangle widest at the base, with a lunulate fovea at the external margin of each lateral ocellus.

Pronotum with two or three transverse striae in the concavity dorsally, laterally bearing strong longitudinal costae, its lateral angles prominent. Anterior declivity finely punctate, shining.

Mesonotum polished and shining, anteriorly with four longitudinal impressed lines extending for about $\frac{1}{3}$, the surface finely punctate, the punctures 2 to 4 diameters apart. The anterior margin with three or four short costae laterally. Scutellum polished and shining, the puncturation as on the mesonotum, divided from the latter by a transverse depression crossed by five to seven costae.

Metanotum with microscopic transverse wrinkles.

Propodeon very strongly and coarsely reticulate, the spaces between the reticulations deeply excavate. The reticulations not covering the dorsal convexity, ending abruptly about $\frac{1}{3}$ from the base towards the median line, brokenly and nearer the base laterally. The space thus enclosed is minutely rugulose. Basal area narrow, with a hexagonal excavation medially, the lateral portions crossed by six to eight costae. The propodeon divided medially by a deep furrow.

Propleura dull, coriaceous.

Prepectus of *mesopleuron* strongly receding anteriorly, the surface shining and covered with exceedingly minute hairs. The lateral surface has a few divergent striae extending from the dorsal angle to about the middle of the sclerite. The angulation, dividing the anterior from the lateral face, carinate, with a row of pits posterior to the carina. The prepectal suture with moderately strong transverse costae.

Mesepisternum strongly convex except for a longitudinal depression extending from the middle of the prepectal suture to the pleural suture, its surface polished and shining, covered with microscopic, evenly spaced punctures. Pleural suture transversely costate, the costae stronger near the middle. Mesepisternum convex dorsally, the ventral $\frac{2}{3}$ recessed, flat, the whole polished and shining. The impression round the articulation of the mesocoxa crossed by transverse costae. Meso-metapleural suture deeply recessed, crossed by four or five costae.

Metapleuron with a few transverse ridges, some of them interrupted, the surface between microscopically rugulose and shining. Sides of propodeon irregularly reticulate, the surface finely rugulose between, shining.

Abdomen polished and shining, the first segment with sparse, minute, piliferous punctures, the following segments with the punctures dense. Sixth ventral segment strongly compressed laterally.

Pubescence and colour. Black. Clypeus and frons below the frontal carina, but extending up the inner margin of the eyes for $\frac{1}{2}$ their length, and the genae, densely clothed with decumbent silvery pile. The space enclosed by the frontal carina and the antennal insertions clothed with griseous pubescence, which, in the margins of the eyes and just above the antennal insertions, shows coppery-golden reflections.

Mandibles flavous at the base externally, their inner margin and tooth piceous, the outer tooth ferruginous. Labrum ferruginous, clothed with golden hair. Maxillae, labium, and their palpi, ochreous.

Scape of antennae flavous ventrally and laterally, fuscous dorsally, the whole sparsely clothed with golden pubescence. Ventral surface of flagellum largely ferruginous or ochreous red, the fifth to eleventh segments sometimes infuscate to nearly piceous apically. Dorsally all are black. Second to twelfth clothed with short griseous pubescence.

Thorax black, prothoracic tubercles, and sometimes the collar, flavous, the latter, when so marked, with a median interruption. Posterior margin of scutellum sometimes flavous. Tegulae piceous merging to ferruginous laterally. Metanotum usually flavous, sometimes black. The whole thorax and propodeon clothed with silvery pubescence, that on the posterior portion of the mesonotum, the scutellum and metanotum griseous with golden reflections.

Legs: coxae black. Anterior and intermediate trochantera, femora and tibiae flavous. Anterior metatarsi and the following joint flavous, the rest ochreous. Intermediate metatarsi flavous basally, infuscate apically, the rest fuscous. Posterior trochantera and femora black, tibiae flavous basally, the distal $\frac{1}{3}$ piceous, tarsi piceous, internal calcar ochreous, external flavous. Claws fuscous with ferruginous tips. All the legs clothed with pubescence which is longest on the lower surface of the femora, mainly silvery but becoming somewhat golden on the tarsi.

Abdomen black, the first segment sparsely, the second to fifth densely covered with decumbent silvery-griseous pubescence. Sixth ventral segment clothed with golden pubescence which is short and dense basally, longer and more sparse apically. Sixth tergite rufescent apically, clothed with golden pubescence, seventh dark ferruginous, not normally visible. Process of hypopygium fuscous with a piceous point.

Wings: veins piceous, ferruginous basally, stigma piceous, membrane clear hyaline. Hind-wings with seven hamuli.

Length, 7·5 mm.

♀. More robust than the male and differs from it in the following points.

Head: frontal carina simple; when viewed from in front with the mouth-parts towards the observer, there is no ridge representing the lateral arms of the Y, only a slight swelling. Clypeus minutely bi-emarginate laterally, the median half produced, transverse, bearing a few strong punctures. Mandibles with a strong tooth on their inner margin, their apices tridentate. Scape of antennae about as long as the last flagellar segment, flagellum widening from base to apex.

Comparative lengths of antennal segments:

Scape	2	3	4	5	6	7	8	9	10	11	12
1·5	0·5	1·75	1·25	1·0	0·9	0·9	0·9	0·9	0·9	0·75	1·5

Propodeon with the basal area similar to the male but the face of the declivity is smooth, shining and minutely punctured, with a few weak striae and rugulosities on its lateral surface running into a band of reticulations dorso-laterally. Median furrow crossed by two or three costae and the surface of the declivity with a few wrinkles on either side of the furrow at about $\frac{1}{4}$ from the articulation of the petiole. Above the articulation of the petiole is a deep excavation as in the male, bounded by a carina and having a few radiating striae within. Pro- and mesopleura similar to the male. Metapleuron shining, with numerous minute striae extending from its posterior margin about halfway across the sclerite. Colour and pubescence. Basal $\frac{2}{3}$ of mandibles flavous externally, median and posterior tooth ferruginous, anterior tooth, inner margin and basal tooth piceous. Mandibles clothed with golden hair. Flagellum of antennae ferruginous beneath, black dorsally. Pronotal collar flavous dorsally, interrupted medially. Tegulae dark fuscous. Scutellum with posterior margin flavous, the colour sometimes extending almost to the anterior

margin, sometimes in a narrow band, more often in a ⊥ shaped mark. Metanotum flavous. Apical tergite of abdomen piceous, its extreme apex ochreous. The rest of the insect coloured as in the male.

Length, 8·5 mm.

Type ♂. Federated Malay States: Perak, Bagan Sĕrai, 1.xii.1931. Bred.

Allotype. F.M.S.: Perak, Bagan Sĕrai, 1.xii.31. Bred.

Paratypes. 3 ♂♂, Bagan Sĕrai, 19.xi.31, 1 ♂, 1.xii. 31, 1 ♂, 5.xii.31, 2 ♀♀, 17.xi.31, 3 ♀♀, 19.xi.31, 1 ♀, 30.xi.31, 1 ♀, 1.xii.31.

All bred from nests obtained at Bagan Sĕrai, Perak, F.M.S.

Type and allotype in Coll. British Museum, paratypes in my own collection.

I have chosen the type and allotype from specimens bred from one nest irrespective of whether they exhibit the most usual colouring of the species.

Habits.

The species appears to be intimately connected with padi fields where it preys on Homoptera which are not infrequently pests on the padi. Mr. W. E. China has very kindly checked my identification of the prey collected. This consisted of the Delphacid, *Sogata furcifera*, Horv., and the Jassid, *Nephotettix bipunctatus*, F.

Sogata was taken in much greater numbers than *Nephotettix*, and only females and nymphs were found in the nests examined. The only imago of *Nephotettix* which was found in the nests was a male.

One cell, the contents of which were preserved, contained the following prey.

2 ♀ imagines *Sogata furcifera*, Horv.
3 ♀ last instar *S. furcifera* nymphs.
3 ? sex, probably 3rd instar *S. furcifera* nymphs.
3 ? sex, probably 2nd instar *S. furcifera* nymphs. One bearing a Dryinid sac, probably of *Pseudogonatopus hospes*, Perk., on the right side of the dorsal surface of the mesothorax.
1 ♂ imago *Nephotettix bipunctatus*, F.
1 ? ♂ probably 3rd instar *N. bipunctatus* nymph.

13

A second cell examined on 22.xi.31 contained fifteen *Sogata furcifera*, one of which, a ? 2nd instar nymph, bore an egg on the mid dorsal line, fixed to the mesothorax and extending forwards as far as the front of the head and backwards to the base of the 3rd abdominal tergum. This nymph, and another in the same cell, bore a Dryinid sac on the left side of the mesothorax.

A third cell contained ten *S. furcifera*, five of which were females and three nymphs of *Nephotettix*, together with a young larva of the *Psenulus*.

With regard to parasitised prey stored by Aculeates, Hamm and Richards (1926, *Trans. Ent. Soc. Lond.*, **1926**: 313) record *Blepharipus ambiguus* (Dahlb.) capturing Dryinidised Typhlocybids in the New Forest and at Oxford, and Hobby (1931, *Proc. Ent. Soc. Lond.*, **6**: 11) records *Mimesa bicolor*, F., capturing Jassids attacked in the same way. Of 9 ♂♂ and 10 ♀♀ *Athysanus sejugendus*, Kbm., seven of each sex bore a Dryinid sac, possibly of *Antaeon* sp., in the region of the mesothorax.

Hamm and Richards suggest that parasitised individuals are less active and thus more readily captured than normal ones and point out that, as the parasitised individuals must in any case perish, their removal is beneficial to the species.

The nest of *Psenulus sogatophagus* is constructed in stems of the grass *Sacciolepis myosuroides*, Ridley, and the insect was discovered accidentally while examining the grass for larvae of the Pyralid moth *Diatraea auricilia* (Dudg.), which is a pest of padi. This grass has large succulent hollow stems and grows in moist places, frequently being rooted at the side of irrigation canals and drains and having its stems floating on the water, the shoot being erect. The nests are made in the floating part of the stems, the entrance usually being just below a node and the first cell just above the previous node. The septa between the cells are composed of a fine translucent white membrane which consists of a number of strands of silk-like appearance. These septa were submitted to Dr. J. A. Simpson of the Institute of Medical Research, Kuala Lumpur, who examined them microscopically and chemically and reported that they closely resembled raw wild silk. Dr. Simpson found the fibres to be colourless and generally structureless, but a few exhibited longitudinal striations. Most of them were 2 to 4 μ wide, but some were about 10 μ in width. Many were coated with a yellowish resin. They behaved chemically in a manner very similar to natural silk.

I have not ascertained the incubation period with certainty, but it seems to be about 24 hours. Feeding and growth are rapid and the larva is full fed in 36 to 48 hours after eclosion from the egg. A light cocoon of brownish silk is spun and the larva adds to the septa dividing its cell from those on either side of it, the posterior one being further strengthened with excreta. The act of defaecation occurs 2 to 4 days after the cocoon is completed, and after a further 3 days pupation takes place. The pupal period lasts 5 to 12 days, giving a total life-cycle with limits of $11\frac{1}{2}$ and 22 days.

The larva has prominent mouth-parts which are clearly visible to the naked eye. The head is well marked and the segmentation clear.

This insect appears to be very local, and I have only found it in one place along the bank of an irrigation distributary, and even then only extending for about ten yards along one bank. Both its prey and the grass in which it nests are widely distributed.

FURTHER COLLECTED RECORDS RELATING TO INSECT MIGRATION

By C. B. Williams, Sc.D.

(Chief Entomologist, Rothamsted Experimental Station.)

[Read December 7th, 1932.]

Since the publication of the second series of these collected records in 1930, *Trans. Ent. Soc. Lond.*, **78** : 139, a number of other cases of mass movement of insects have been brought to my notice, chiefly from correspondents in the tropics. These are now put on record in order to be available for all students of the subject. My thanks are due to all the observers for their co-operation in this study.

The following records are given below :—

Vanessa cardui.

(1) in Nigeria, (2) in Mauritius, (3) in Switzerland, (4) in U.S.A.

African Records.

(5) *Atella phalanta* in Tanganyika.
(6–7) *Andronymus neander* in Kenya and Uganda.
(8–17) *Catopsilia florella* and *Belenois* spp. in Natal, Nyasaland, Tanganyika and Kenya Colony.
(18) ? *Libythea labdaca* in Nigeria.

Asiatic Records.

(19) *Catopsilia* sp. in Malay States.
(20) *Terias hecabe* in Ceylon.
(21) *Appias libythea* in Ceylon.

Australian Records.

(22) *Danais chrysippus* in New South Wales.
(23) *Belenois java* in Victoria.

European Records.

(24) *Vanessa atalanta* in England.

American Records.

(25) *Catopsilia statira* in Dutch Guiana.
(26–27) *Urania fulgens* in Panama and Costa Rica.
(28) *Libythea bachmanni* in U.S.A.
(29) *Danais plexippus* in U.S.A.
(30) *Nathalis iole* in U.S.A.

Miscellaneous.

(31) Capture of Butterfly in the Arctic in 1881.

Dragonflies.

(31) *Libellula quadrimaculata* in North Wales.
(33) *Hemianax ephippiger* in the Red Sea.
(34) *Pantala flavescens* in Kenya.

(1) *Vanessa cardui* in Nigeria.

Mr. O. B. Lean, writing from Yandev, Makurdi, Nigeria, on 26th October, 1928, gives the following information about the appearance of *V. cardui*.

" I have not kept observations on *Vanessa cardui* until this year, although it appears each year at Ibadan. I am now stationed in the Benue Province. The butterfly appeared here towards the end of September [1928] and by the end of the month they were very numerous, as they are still. At Katsina Ala on Sept. 27th there were hundreds of them and many pairs were seen *in coitu*."

(2) *Vanessa cardui* in Mauritius.

Mr. R. E. Vaughan sends me the following note on the occurrence of *Vanessa cardui* in Mauritius.

" On an old volcano near Curepipe I often see *V. cardui*. Their appearance is very sporadic. Sometimes for months on end it is impossible to find one, and then they appear in comparatively large numbers. They are confined to this very restricted area (about 75–100 acres), only very rarely coming down into the settlement of Curepipe. It is possible that they are immigrants."

It should be noted that the nearest land to Mauritius (with the exception of the equally small island of Reunion) is Madagascar, about five hundred miles away to the West.

(3) *Vanessa cardui* in Switzerland in 1931.

Miss R. M. Thackeray allows me to record the following notes on two flights of " Painted Ladies " that she observed in Switzerland in 1931.

(1) On 8th August, 1931, at Belvedere, near Champex, about 11–12 a.m., butterflies were flying continuously towards the S.S.E. in groups of five or six, about 10–20 feet below the Belvedere Ridge on the west side, at an altitude of about 5,500 feet. The day was clear, sunny and warm, and the butterflies in fairly good condition.

(2) A second flight was observed on 20th August across the top of the Val d'Arpette. Only one or two butterflies a minute passed on a front of 100 yards. The flight direction was a little West of South.

(4) *Vanessa cardui* in Utah, U.S.A., in 1931.

Mr. Dwight Buchanan of the University of Minnesota drew my attention to a cutting from a Utah newspaper recording a migration of " *Argynnis aphrodite* " to the northwards in the spring of 1931.

Further inquiry from the State Entomologist elicited the information that the newspaper identification was incorrect, the butterfly concerned being *Vanessa cardui*.

The flight was observed chiefly at Richmond, Utah, for about three days. It was reported by automobile drivers to extend from Beaver City to Provo, Utah, a distance of about 150 miles. The butterflies seemed to be following the valleys. They were swarming along the highways in countless thousands.

(5) *Atella phalanta* in Tanganyika.

I am indebted to Mr. J. W. McHardy for the following record :—

On 29th December, 1929, he observed a flight of butterflies to the S. by W. at Dar-es-Salaam, Tanganyika. It was first observed at 10.30 a.m., at which time it was going strong; later it dwindled off and stopped completely between 2.30 and 3 p.m. The wind was from the E.N.E. and the weather sunny. The numbers crossing a fifty-yard front in successive minutes were 7; 9; 11; 13; 17; 15; or an average of 12 per minute.

No migration had been noted in the previous days, and although a careful watch was kept on the following days no further flight was seen, nor was the species seen to be resting in the district. Owing to illness Mr. McHardy was unable to get any information as to the extent of the flight.

One specimen was sent to me which was *Atella phalanta*. This insect has been previously recorded as migrating in East Africa and the Orient.

(6) *Andronymus neander* in Kenya.

Mr. R. M. Graham of the Forest Department of Kenya Colony kindly sent me the following record :—

One day in March 1930 at about 1.30 p.m. he noticed many hundreds of a butterfly flying at a locality near the coast of Kenya, about 15 miles south of Malindi, and about five miles from the sea. The direction of flight was a little South of West, *i.e.* going down the coast, but slightly inland, and actually at the moment following the edge of a big block of forest. There was very little wind at the time, and the height of the flight was from 8–15 feet above the ground.

The insects were swift flyers and it was not easy to estimate their numbers, but roughly there were about 40 individuals at any one moment on an area about 30 yards square.

The flight lasted for some hours at least, and may have been going on before it was first observed. For some days previously unusual numbers had been noted without, however, any directional flight being realised.

At about 5 p.m. on the day of the observed flight smaller numbers of the butterflies were flying in the opposite direction, though some still flew towards the West. They were also settling in great numbers on a local shrub (*Vernonia zanzibarensis*, Linn.) which was flowering freely. Normally they are very difficult to catch, but in this case he had no difficulty in taking a couple of specimens with his hand.

Mr. Graham sent me two specimens both of which were *Andronymus neander*, a Hesperid butterfly which has on several previous occasions been recorded migrating in East Africa.

(7) *Andronymus neander* in Uganda.

Mr. C. Hazel informs me that when at Makimuga (Bwamba), Uganda, on 28th October, 1931, he saw a large swarm of insects, which he at first took for locusts, flying due North at an average height of about 20 feet. They were flying very rapidly, and it was only with difficulty that he was able to catch a single specimen. The insects were passing in a fairly dense swarm for about one hour.

The specimen enclosed with the letter was the Hesperid butterfly, *Andronymus neander*, which has previously been recorded migrating in Kenya and Tanganyika but not before in Uganda.

This record is particularly interesting as the six previously known flights of

this species have all occurred in March, April and early May and with one exception have been towards the south.

(8) *Catopsilia florella* in Natal in 1929.

Mr. K. M. Pennington kindly sends me the following record :—

From 12–17th March, 1929, he observed large numbers of *Catopsilia florella* flying past Michaelhouse School at Balgowan, Natal, from South-West to North-East. The weather was generally warm and calm, but at times there was a slight N.W. wind. The maximum flight was reached about the fourth day when an average of 47 specimens passed per minute on a front of about 100 yards.

(9) *Belenois mesentina* in Natal in 1929.

Mr. K. M. Pennington informs me that on 13th November, 1929, a flight of *Belenois mesentina* was crossing a cricket-ground at Balgowan, Natal, about one butterfly every four seconds, from South-West to North-East. The butterflies seldom settled, and when they did it was only to suck at some flowers that lay in their path. The day was a hot one preceded and followed by cold and cloudy days.

Balgowan is about 35 miles N.W. of Pietermaritzburg.

(10) *Catopsilia florella* and *Belenois* sp. in Nyasaland in 1929.

Dr. H. H. Storey sends me the information that on 18th December, 1929, *Catopsilia florella* was flying in fair numbers to the E.N.E. at Mlanje, Nyasaland. The wind was from the West. On the following day at mid-day the same butterfly was flying to the East at Lauderdale, Mlanje, and was still going in the same direction at 4 p.m., while at this hour some individuals of a species of *Belenois* were passing to the N.E. There was no wind on the 19th December.

Unfortunately no specimens were sent, so that the species of *Belenois* cannot be determined.

(11) *Belenois severina* in Nyasaland in 1930.

Mr. E. H. Lilford recently sent me two males and two females of *Belenois severina* and one *Terias senegalensis*, with the information that they had been taken from a flight of butterflies that had been passing for four days previous to the 8th April, 1930. The locality of the flight was Karonga, Nyasaland, and the direction to the S.E.

(12) *Belenois severina* at Amani, Tanganyika, in 1929.

From the end of May to the end of July 1929 there was a thin but steady migration of white butterflies at Amani in N.E. Tanganyika. The following notes were sent to me by Dr. H. H. Storey :—

On 28th May, 1929, a distinct flight of white butterflies with dark markings was noted moving slowly to South or South-West. They were seen mainly during sunny periods. At 1 p.m. two or three per minute were passing. On the following day was again noted at 1 p.m. and 3.15 p.m. going to the South, the wind being slightly W. Two specimens were captured by Dr. Storey and identified, by comparison with the museum collection, as *Belenois severina*. The following three days were mostly wet, but on the 3rd June the butterflies were again passing to the South in fine sunny intervals. On the 5th June they

were passing slowly and stopping to feed, the direction of flight being the same and the wind South by West.

The 6th June was the first really fine day and the flight was in progress steadily all day, with apparently *B. mesentina* and *B. severina* both present. Many of the *B. severina* were very battered, only just able to fly. A few *C. florella* were also present apparently also going to the South. On 9th and 10th June the flight was still in progress in small numbers. From 11–17th June the weather was bad and only very few butterflies were seen. On the 18th it was fine again, but very few butterflies were on the move to the South. On the 19th flight was much more distinct, still to the South against a South wind. On the 24th June *Belenois* were "streaming over," some to the South, which Dr. Storey thinks were *B. severina* and others to the East, which he thinks were *B. mesentina*. On the 25th the flight was more definitely to the East with the wind still from the South.

On 30th June on open down land at Sangarawe, about six miles from Amani, there was a steady flight to the S.E. in the teeth of a strong wind. On reaching the crest of the ridge the butterflies were often blown back long distances by gusts, but returned on their old line. The numbers were about four or five per minute on a 30-yard front.

During July a very sparse movement continued and was observed on many fine intervals. The second half of the month was very wet and little was seen, but on 29th July Dr. Storey noted that a few were passing still going to the South. No movement was observed during August and September.

This flight may be compared with a similar one which took place at Amani just a year previously. This previous flight lasted from the end of May to the beginning of Sept. 1928, in the early part *B. severina* and *B. mesentina* were both present, but later the *mesentina* disappeared and only *severina* was seen. The direction of this flight was to S.E. and E. (see Williams, 1930, *Trans. Ent. Soc. Lond.*, **78 :** 150–156).

(13) White Butterflies at Lushoto, Tanganyika, in 1929.

Mr. T. L. Priestnall sends the following notes about flights of butterflies at Shume near Lushoto in the West Usambara Hills, N.E. Tanganyika, at an altitude of about 5,000 feet.

"At 9.30 on 27th November, 1929, I first noticed a quantity of butterflies flying over East; by 10.30 the sky was thick with them. At 1 p.m. for some reason they were flying in all directions, N., S., E. and W., but by 2 p.m. they were all flying due W. back on their own tracks. At 3.30 a storm broke from the East and the ground was simply littered with butterflies that had been beaten down. On the 28th November there appeared to be no migration, but all I watched were feeding. This continued until the 2nd December when the flight started off to the East and lasted till the 9th December, but the numbers were not so large as at first. On the 10th December they were again doubling back on their tracks, and I noticed away in the East a heavy cloud. This did not reach to where I was, but I found that five miles to the East there had been a storm which I judge had turned them back. On the 14th no butterflies were left. On the 22nd December the flight appeared to be again going to the East, and large numbers of butterflies were collected in damp spots. From the 24–28th December I was absent from Shume, but on my return there were countless numbers feeding, but not moving. On 8th January, 1930, they were again moving to the West and by the 10th January none were left." No

further movement was seen until February (for the account of which see Williams, 1931, *Proc. Roy. Phys. Soc. Edinburgh*, **22 :** 35).

From 28th December to 8th January they were noticed to be mating.

(14) *Belenois mesentina* and *Catopsilia florella* in Kenya in January 1932.

Mr. R. M. Graham of the Forest Dept., Kenya Colony sends me the following interesting record :—On January 28th, 1932, at Londiani, Kenya, there was a small, but definite, migration of butterflies to the E.N.E. The flight lasted from 9 a.m. to 4.30 p.m. with a maximum about 11.30 a.m. to 3 p.m. Half a dozen were usually in sight at one moment on an area of 30 × 50 yards. The butterflies were flying straight into the teeth of a fairly steady, hot-weather breeze from the E.N.E. They were flying fast and not many took any notice of the few flowers left in the garden. The season was the middle of the dry season and there had been no rain in Londiani district for about six weeks. About a week previously there had, however, been about 3 inches of rain in Nairobi and probably about the same in the direction in which they were heading. Mr. Graham sent 11 specimens as follows :—

5 *Belenois mesentina*,
4 *Catopsilia florella*,
1 *Mylothris ruppelli*,
1 *Precis octavia sesamus*.

He also reported that in addition to these other insects were seen in the flight including (1) a large black *Papilio*, spotted and barred with light yellow, (2) a common brown and yellow slow flying " Danaine " and (3) a few small *Lycaena*-like ones.

(15) *Catopsilia florella, Belenois mesentina* and *Belenois severina* in Kenya in April and May 1932.

Mr. R. M. Graham sends me the following information :—

A migration started on 8th April, 1932, and lasted till 11th, when a few stragglers only were passing. The weather conditions, direction of wind and direction of flight were about the same as in the flight previously recorded in January (see above : *i.e.* flight to E.N.E., wind from E.N.E.). In March there had been fairly general and heavy rains, but for about two weeks previous to flight there was no rain. The 11th was overcast. The migration started on the 8th, a steady flight from about 10.30–4.30, but the numbers of insects visible at any one time were only about one-quarter to one-sixth as great as that of the average of the January flight. The flight continued on the 9th and 10th from about 9 a.m.–4.30 p.m., the numbers being greater than on the first day and about as many as in the January flight. On the 11th a few stragglers till about 1 a.m. when the sky became very overcast and all movement ceased. He writes : " Practically all are white butterflies [*Belenois*, see below] with a few scattered specimens of other species. These are probably migrating as none seem to take much notice of the few flowers in the garden. A few dragonflies are also in the flight. They *may* be local as they do occur here, but they look as if they are migrating with the butterflies. On the other hand, there are so few (one passes every few minutes) that, were it not for the butterflies, one would not notice them."

Mr. Graham sent twelve specimens which were as follows :—

5 *Belenois mesentina*, 4 males and 1 female,
4 *Catopsilia florella*, 2 males and 2 females (1 variety *rhadia*),
1 *Danais chrysippus* form *dorippus*,
1 *Mylothris sagala*,
1 *Lycaenesthes* sp. (LYCAENIDAE).

No specimens of the dragonfly were sent.

On 2nd May Mr. Graham again wrote to me giving further particulars as follows :—" On the 12 -16th April the migration continued on a slightly reduced scale. On the 17th April M. D. Graham [brother of the writer] noted that the wind was from the N.N.E. and that the flight was strong and contained the following species :—(1) *D. misippus* both sexes, (2) *C. florella*, majority white, only a few yellow, (3) *Danais chrysippus* both sexes and varieties *alcippus* and *dorippus*, (4) *Junonia boopis*, (5 and 6) two species of *Precis* unidentified, and (7) some unclassified PIERIDAE." (For identification of specimens sent see below.)

On the 17th and 18th Mr. R. M. Graham was about 18 miles South of Londiani and saw white butterflies going N.E. or N.N.E. as at Londiani.

Mr. Graham goes on to say : " For the remainder of the month the migration continued spasmodically on all fine days. We have been having a certain amount of rain and the wind has often changed at about 3 p.m. from N.N.E. to S.W. When it blows from the latter direction it usually gets cold at this time of the year and we get rain, and, of course, under such conditions no butterflies are seen."

" On 23rd April my brother was about 30 miles West of Londiani and passed through a belt of the same (presumably) migration of chiefly white butterflies going N.N.E."

" To-day [2nd May] at Londiani there was practically no wind all the morning. It was warm and the migration was good. My brother estimated that butterflies were crossing a space about 30 yards wide in front of the house at a rate of about 4000 per hour. There were a good many more species represented than there have been during the last fortnight."

Mr. Graham sent 26 specimens captured by his brother on 17th April. They were as follows :—

Belenois severina, 10 females, 12 males,
Catopsilia florella, 1 yellow female,
Libythea laius, 1 female,
Hypolimnas misippus, 1 male,
Precis oenone, 1 male.

It will be noticed that the *Belenois* sent on 11th April were all *mesentina*, while those captured on 17th April were all *severina*. So that some time between these two dates the species in the flight had changed. I have already shown (Williams, *Migration of Butterflies*, 1930, pp. 91 and 97) that in general the migration season of *B. mesentina* is January to April and that of *B. severina* April to July, but this is a most interesting confirmation of the rapidity of the change.

In conclusion Mr. Graham sums up : " It seems that this flight is taking place from the low country near Lake Victoria along certain well-defined routes, these routes being the large valleys leading up from the Lake. The Forest Station at Londiani is actually on what is a pass; and the route followed by the

Nairobi–Kisumu railway, by locust swarms and hoppers and by the butterflies, and the migrations noted in this letter North and South of Londiani are also taking place over passes. Thus, whether the main direction of the flight is N.E. or not I don't know since they may change direction when they get over this range of hills."

In connection with Mr. Graham's record of *Belenois severina* at the end of April it should be noted that Major Moysey (July 1932, *J. East Afr. Nat. Hist. Soc.*, **42–43 :** 177–178) records a large flight of the same species to the N.E. from 29th April to 12th May, 1932, at Mount Elgon, Kenya, which is about 100 miles N.W. of Londiani and so directly across the line of flight.

(16) White Butterflies in Kenya in May and June 1932.

Mr. R. M. Graham sends me the following notes; unfortunately, however, without specimens.

On 14th May, 1932, a Mr. Peto living about 2 miles from Londiani, Kenya, saw an extremely dense flight of white butterflies going to N.E. or E.N.E. He had seen swarms before but never one so thick.

On 17th May Mr. Graham saw a few white butterflies flying to N.E. at Londiani.

On 5–10th June Mr. Graham noted at Londiani a thin flight of white butterflies, 4–5 per minute on a 50-yard front, flying in the opposite direction from that usually seen, *i.e.* towards the S.W. It only lasted for a few hours each day when the sun was shining. The first half of June was dry between two wet periods.

(17) *Catopsilia florella* in Kenya in June 1932.

Major Moysey kindly allows me to record the following notes on a flight of *Catopsilia florella* observed by him at Kiminini, Mount Elgon, Kenya Colony, in 1932.

" *June 3rd :* noticed steady flight of *Catopsilia* moving to South-West. No wind. At 3.30 p.m. I counted them passing through a space of 30 yards for 15 minutes. Result 16 males and 8 females.

" *June 4th :* wind nil. Direction of flight South-West to South. At 10.25–10.40 a.m. 14 males and one female counted as above.

" *June 5th :* from 1.10–1.20 p.m. four males and one female.

" *June 6th :* wind N.E. Slight direction to South. From 2.50–3.15 p.m. 36 males and 12 females passed.

" *June 7th–10th :* an irregular flow continued each day at the rate of about one per minute moving South to South-West."

(18) Brown Butterfly in S. Nigeria in 1931.

Mr. A. F. Lamb of the Forest Department, Nigeria, writes from Akilla, S. Nigeria, that " on 8th May, 1931, a thin stream of brown butterflies, with a few whites intermingled, passed my house flying in a S.S.W. direction. The butterflies were similar to a small fritillary in size and had slight tails to the back wings. Their colour was a dull brown with an appearance of grey on the underside. The whites were similar in size. The insects seldom settled and never rested for more than a few seconds."

Mr. Lamb was unable to catch any, but the description of the brown butterfly applies fairly well to *Libythea labdaca* which is known to migrate in Nigeria in March, April and May and usually towards the South. It is impossible to suggest the identity of the Pierid.

(19) *Catopsilia* sp. in Pahang, Federated Malay States.

The following is an account of a flight seen by Dr. T. A. Buckley of the Forest Department of the Federated Malay States.

On 3rd June, 1930, Dr. Buckley noticed unusual numbers of butterflies along the road from Benta to Jerantat from about 12.30–2.30 p.m. over a distance of about 30 miles. On the following day about 10 a.m. the numbers became exceedingly great after he had crossed the Penang River. They were always hovering over the sunny side of the road and not on the shady side. When his motor-car stopped he saw that the butterflies were drifting slowly towards the West, but he could not say if this was a deliberate migration or due to some local air current. The numbers thinned as he approached the east coast, but for 80 or 90 miles there was an unbroken stream of millions of butterflies.

At one place he noticed a small patch of stagnant water entirely covered with close-packed settled butterflies, and in other places patches of cow-dung were similarly shrouded, individuals leaving and alighting continually.

The butterflies were described as " a little larger than the English Cabbage White without special markings. In flight they appeared yellow, but close at hand greenish." There is little doubt that it was some species of *Catopsilia* several of which are known to migrate in this part of the world.

I am indebted to Mr. N. C. E. Miller for sending me this record from Dr. Buckley.

(20) *Terias hecabe* in Ceylon.

Sir Norman Lamont allows me to record that on 25th January, 1931, when he was travelling by train from Colombo to Nuwara Eliya, he observed some way above Hatton about 11 a.m. an immense flight of *Terias hecabe*, L. They seemed to be all through the valley at all elevations and when the train crossed a bridge they could be seen in yellow patches in the bed of the river below. There was little if any wind, what there was was from the North, and the insects were moving indefinitely to the South. The day was bright and sunny.

(21) *Appias libythea* in Ceylon.

Sir Norman Lamont also informs me that on 13th March, 1931, when motoring in the morning from Kandy to Sigiriya, at a distance of about 3 miles from Sigiriya he ran into a " snow-storm " of *Appias libythea*. They filled the road for two or three miles from the ground-level to the height of the low trees (say 25 feet), being most numerous below 6 feet. On returning about 2.30 the flight was as numerous as before. The wind, if any, was a light air from the North and the movements of the insects were vaguely to the South, *i.e.* with the wind, but they had no definite purposeful movement as one usually associates with migration. The day was bright and sunny after two days of heavy rain. The males appeared to predominate, but none were captured to confirm this.

(22) *Danais chrysippus petilia* in New South Wales.

Dr. G. A. Waterhouse (writing in March 1930) informs me that about fifteen years previously he had seen a flight of *Danais chrysippus petilia* in Sydney. The general direction was from North to South and the butterflies were even flying in the main streets of the city, whereas in normal years the butterfly is quite a rarity.

(23) *Belenois java* in Victoria.

Mr. G. Lyell informs me that the only migratory butterfly of which he has personal knowledge is *Belenois java*. The direction of flight of this species at Gisborne, Victoria, is always from South to North. The numbers are nothing like those seen in the tropics. If half a dozen specimens are in view at one moment he should consider it an average flight, and sometimes single examples only are to be seen on the wing, but all going towards the North. Speaking from memory he thinks that males are about three times as common as females.

(24) *Vanessa atalanta* in Lundy Island, England.

Mr. C. Elton sends me the following note on *Vanessa atalanta* observed by himself and Dr. T. G. Longstaff, at Lundy Island, in the Bristol Channel.

" On 4th September, 1927, a migration of ' Red Admiral ' butterflies, all apparently in fresh condition, all flying South or S.S.W. The Island is in the Bristol Channel about 20 miles from Devonshire and 35 from Wales. We were at the South end. The butterflies were seen passing from 4 p.m.–7.30 p.m. Observations only started at 4 and stopped from 5–5.30. Between 4 and 5 p.m. we saw 9 butterflies all flying singly except one pair. All had the same direction and flew rather fast, about 10–30 feet from the ground. The wind was faint from the N.E. One settled on a patch of nettles and then flew on again. The others did not settle.

" Between 5.30 and 7.30 I saw five more in the vicinity all following the same direction and flying fast and singly. The first four of them were flying in a N.E. wind which then dropped and changed so that the last of the five, still flying South, was in a light West wind. After 7.30 no more were seen that night."

(25) *Catopsilia statira* in Dutch Guiana.

Through the kindness of Mr. Tetley, of the Bristol Museum, I am able to record the following :—

In the Bristol Museum there are two specimens of *Catopsilia statira*, one male and one female, sent from Dutch Guiana by Mr. R. N. Savory, on the 14th August, 1924. On the label is the following note : " Literally millions of these butterflies have passed over our newly-cleared land, during the past two or three days, all flying inland from the sea. They did not settle at all, but continued across the clearing and on up over the bush at the back. They took no notice of flowers in the clearing. They were flying about 3–9 feet from the ground, rising to fly over the forest at the back."

Unfortunately the exact locality of the flight is not at present known.

(26) *Urania fulgens* in Panama.

Through the kindness of Mr. B. C. Tillette I am able to record the following observations made by his son when on a boat going through the Panama Canal en route to New Zealand. On 1st August, 1931, when approaching the Pacific Lock from Culebra Cut, about 3 p.m., a large number of moths were seen flying from S.W. to N.E. While many of these were to be seen during the whole transit it was not till this vicinity was reached that there were enough to attract general attention. It was estimated that there were about 200 crossing the upper deck of the ship (about 480 feet long) at one moment.

A gentle south-westerly breeze was blowing at the time and the direction of the flight took the moths across the canal.

One specimen captured on the deck was brought to London and identified by Mr. A. G. Gabriel as *Urania fulgens*, a well-known migrant in that part of the world.

At the time that he sent me the above information Mr. B. C. Tillette informed me that he hoped to prepare an article for a magazine about the flight, but I have heard nothing further from him about this and I have been unable to discover his present address.

(27) *Urania fulgens* in Costa Rica.

Mr. F. G. Wallace informs me that during April and May of 1928 occasional specimens of this insect were seen flying through the city of Cartago, Costa Rica, and its environs, always to the North and with an apparent purpose, never stopping or changing direction. They flew at a height of from 3 to perhaps 10 feet. From three to a dozen would be seen in a day's casual observation. Specimens were collected at the Monte Verde Farm near the Rio Cimarrones, East of Sicuizzes, on 20th May, flying to the North at this locality also.

(28) Migration of *Libythea bachmanni* in Nebraska, U.S.A.

Mr. R. W. Dawson informs me that he witnessed a migratory flight of *Libythea bachmanni* at Mitchell, Scotts Bluff County, West Nebraska, U.S.A., on 20th August, 1916. Hundreds were all going in the same direction within two feet of the ground, but the exact direction was not recorded. The specimens were all somewhat worn, and the day was bright and sunny. This butterfly is in general very rare in the district.

(29) Records relating to the Movements of *Danais plexippus* in U.S.A.

(1) Dr. R. Matheson of Cornell University informs me that he found a swarm of hundreds of thousands of this butterfly in a 15-acre woodland at Brookings, S. Dakota, one Sunday at the end of September in about 1907 or 1908. He returned the next day to collect some specimens, but all had disappeared.

(2) Mr. Donald Denning informs me that he found a large swarm of this butterfly at Sedan, Minnesota on 2nd September, 1929. He captured 40 specimens which he kindly presented to me. An examination shows them to consist of 27 males and 13 females.

(3) Dr. E. Lutz informs me that Mr. E. N. Cory reported to him in a letter that a swarm of *E. plexippus* appeared on 24th September, 1931, on some trees on Solomons Island, S. Maryland. On the following day all had disappeared except a few stragglers which returned to the trees on which the main swarm had clustered.

(30) Possibility of Migration of *Nathalis iole* in U.S.A.

Mr. R. W. Dawson, of the University of Minnesota, informs me that the Pierid butterfly, *Nathalis iole*, suddenly appeared in large numbers in the vicinity of St. Paul and Minneapolis, Minnesota, U.S.A., in September and October 1931. They were at their maximum about 22nd September and were still common on 4th October. On one occasion over four hundred were captured in two hours. He had never seen a single specimen in the state of Minnesota in the previous nine years.

In the collection of the University of Minnesota there were three specimens

of this species believed to have been captured in the district. They were labelled " 6th October. O. Lugger." No year was given, but as O. Lugger died about 1901 or 1902 there is no evidence that any specimens have been captured in the last 30 years.

(31) Capture of Butterfly in the Arctic in 1881.

Dr. Vilhjalmur Stefanson has called my attention to a most remarkable record of a living butterfly in the extreme north, from de Long's *Voyage of the Jeanette* (London, 1883), Vol. 2, p. 639.

In the year 1881 Captain de Long in the ship " Jeannette " was attempting the " North East Passage " from Behring Strait to North Cape. On the 12th June, 1881, their ship was crushed by the ice a little to the N.E. of the " New Siberian Islands " on " Liakhov Island " near " Henrietta Island " and approximately in lat. 77° N. and long. 155° E. The ship was abandoned and the survivors with sledges reached " Bennett Island " (between 76° and 77° N. and 147° E.) on the 16th July.

Four days previously to this on the 12th July, 1881, Captain de Long records in his diary as follows : " Many dovekies [Guillemots] were seen, several gulls, one auk and, strange to say, the Doctor picked up a live butterfly, which I have preserved. This last is not a habitue of the ice and was certainly blown from the land by the south-easter of yesterday, or by the south-wester following it."

Although Captain de Long says that he kept the specimen it is extremely unlikely that it still exists, as Captain de Long and a number of his men lost their lives during their attempt to reach civilisation. However I am making inquiries to see if by any chance the butterfly exists and could be identified. The locality of capture is about 700 miles north of the Arctic Circle.

(32) *Libellula quadrimaculata* in North Wales.

The late Mr. T. A. Coward has allowed me to record some notes that he collected on an immigration of the dragonfly *L. quadrimaculata.*

The flight occurred in June 1911. He received a specimen of this insect from Dr. F. S. Jackson of Aberdovey with the information that on the 2nd June they were " literally in thousands; they appeared to be flying slowly eastward from about 11 a.m., to about 4 p.m. The wind was due East at the time—a slight breeze—with a very hot sun."

Mr. R. W. Jones also wrote to him from Llandudno as follows :—

" From about noon on 1st June till dusk on the 2nd dragonflies migrated over the Great Orme and Llandudno. People on the Orme, where the insects were flying rather low, caught and killed great numbers of them, and found it difficult to evade them, but they flew at a higher elevation over the town. I was amazed at seeing so many. They arrived on the Orme from a South-Westerly direction (from Anglesey), but so soon as they reached the headland they flew directly South-East. Apparently all the flies were of the same species."

Later Mr. Coward heard that swarms had been seen at Treaddun near Holyhead, also on 1st June, flying south.

On 1st and 2nd the weather was anticyclonic. Wind in N. Wales on 1st June at first light from North, later N.W. On the 2nd June at first calm, later light breezes from the East.

The flight at Aberdovey is briefly referred to by the late W. J. Lucas in the

Entomologist, 1912, **45** : 144. He says : " It is worthy of note that on 2nd June a swarm of dragonflies was seen flying *East* near Aberdovey. The flight was noticed by several people at Towyn and Aberdovey and it was so large as to be mentioned in one of the local papers." The species was, however, not known.

(33) *Hemianax ephippiger* in the Red Sea.

Dr. L. O. Howard informs me that in October 1931 he was on board S.S. " President Fillmore " in the Red Sea on a voyage from Colombo to Suez. The ship arrived in Suez on the 19th. About two nights previously, he thinks on the night of the 17th, about 10 p.m., some dozens of dragonflies came on board and entered the brilliantly lighted saloon. The locality was near the Straits of Bab-el-Mandeb and the ship was about 90 miles from land. There was a moderate wind from the N.W.

A specimen captured was identified by Mons. L. Berland as a male of *H. ephippiger*, Burm.

(34) Dragonflies migrating in Kenya in 1931 and 1932.

Mr. R. M. Graham writes on 4th October, 1931, from Londiani, Kenya, that " starting from the 2nd October—or possibly earlier—we have had a constant stream of dragonflies coming over the house from, roughly, the direction of Lake Victoria; actually from about the S.W. On the 2nd and 3rd there was a fairly stiff breeze from the N.N.W. approximately. To-day (4th) there is a slight breeze only. The insects are travelling at from 8–10 miles per hour. Over an area of lawn about 20 × 50 yards there are usually 6–20 in flight. We have had almost daily rains till 30th September, but it has been dry since then."

Three specimens were sent all of which were *Pantala flavescens*.

Again in 1932 Mr. Graham writes that from 14–17th August, at Londiani, dragonflies were migrating towards the N.E. at a rate of about 8–10 per minute on a 50-yards front. After that date none were seen. Unfortunately no specimens were captured so that the species cannot be identified. The direction of flight is the same as that noted in 1931, but the time of the year is different.

ON THE ANATOMY OF SOME BRITISH ALEURODIDAE

By V. G. Deshpande, M.Ag. (Bombay), Ph.D. (Edin.).

[Read 7th December, 1932.]

With Plates VI to IX.

Contents.

	PAGE
Introduction	117
Method and Technique	119
External Anatomy of :—	
(1) *A. brassicae*	119
(2) *A. lonicerae*	126
(3) *T. sonchi*	126
Internal Anatomy of *A. brassicae*	127
Bibliography	130
List of Abbreviations used in the Plates	131

Introduction.

In some works on the morphology of the Homoptera, *Cicada* has been taken as a basis for the generalised structure. In the suborder Sternorhyncha *Psylla* has been studied, but there are hardly any references directly dealing with the Aleurodidae except the general morphological and anatomical features described by Quaintance and Baker (1913) in their "Classification of the Aleurodidae, Part I."

No one has studied the structure of any of the British species, and I propose to discuss here their morphological features. In all I came across 15 species, all of which belong to the subfamily Aleurodinae.

The eggs are all stalked, but the attachment of the stalk is not of the same type in all. In some it is central, in others it is lateral, and in some it is far towards one side, always to the convex side. The shape and size of the egg varies in different species. The usual shape is oval, pointed at one end, and generally curved on one side. The maximum size is ·38 mm. × ·18 mm. Eggs are laid in circles, semi-circles and in some cases scattered. Their colour is greenish-yellow, yellow or whitish-yellow.

The larvae of all the species are nearly of the same shape and structure though the pupae differ considerably, especially in the form and structure of the vasiform orifice.

The Adult.

Eyes: In general two kinds of compound eyes are found, (1) divided and (2) not divided or reniform. Some species like *A. brassicae*, *A. proletella*, *A. rubi*, *A. lonicerae* and *A. fragariae* have the upper and lower divisions of the eyes quite separate (Pl. VI, figs. 1 and 2). *T. sonchi* and *T. vaporariorum* (Pl. VI, fig. 3) have divided eyes, but the division is less wide and one of the

lenses very nearly touches the other division. The reniform structure in the undivided eye is formed by the two divisions of the eye being joined by the lenses touching one another like a bridge. In *rubicola* (Pl. VI, fig. 5) the bridge is formed by one lens, in *phillyreae* (Pl. VI, fig. 6) and *immaculata* by three or four lenses, in *quercus*, *chittendeni* and *azaleae* by two (Pl. VI, fig. 4). In the divided eyes there is a great difference in the size of the lenses of the upper and lower divisions, but the difference is not so marked in the case of species with undivided eyes, especially in the last two species in which it becomes hardly recognisable. The position of the ocellus (Pl. VI, fig. 3) is always anterior to and nearly touching the upper division of the eye and is not strikingly different in the various species. There are about 60 lenses in the upper division of the eye and 50 in the lower. The diameter of the bigger lenses varies from ·006 mm. to ·010 mm., and that of the smaller ones from ·003 mm. to ·004 mm. The maximum diameter of the ocellus is ·008 mm.

Antenna: In general the form of the antenna is the same in all species. The length is variable. The seventh segment is not always the smallest as stated by Quaintance and Baker, and very often it is the fourth that is so. The pit sensoria number three on the third segment, one on the fifth and one on the seventh (Pl. VI, fig. 12).

Rostrum (Pl. VI, fig. 8): The structure is the same in all the species, though the length varies. It is relatively longer in species with immaculate wings than in the spotted ones.

Legs: The length is variable, but the general structure is the same. The number of spines on the tibia varies from species to species. The tarsal joints of the middle legs are invariably the smallest of the three, while all other parts are proportionately intermediate.

At the junction of the tarsus with the claws are three small sclerites centrally placed in a row (Pl. VIII, fig. 7). These are kept in position by muscular attachments to the claws on both the sides and are fixed in the hollow of the distal end of the tarsus. Their function appears to be to facilitate the movement of the claws and even the paronychium. In Orthoptera there are found two such sclerites, which Snodgrass (1928) has called "the planta and the unguitractor plate" (and the part is called the pretarsus), the pad-like structure which follows these two sclerites being called the "aerolium." In the Aleurodids, to the three sclerites above referred to, the paronychium is attached distally and is apparently helped to move by them. The organ, which is hairy and blade-like, has been called the "pulvillus" (Pl. VIII, fig. 7), but this appears to be a misnomer. Quaintance and Baker in their "Classification of the Aleurodidae, Part I," on page 14, remark that the Psyllids have a prominent bilobed pulvillus, but in the Aleurodids it is undivided and single. The pulvillus is usually a bilobed structure and always has its origin near the claws. The empodium is a single structure and originates in the centre. It can also exist without the pulvillus as can be seen from the leg of a grasshopper where the pad-like empodium is called the aerolium. I prefer therefore to treat the paronychium as an empodium, rather than as a pulvillus.

Wings: The size differs from species to species, but the structure and venation do not vary so much except that in some species they are spotted and in some they are immaculate.

Abdomen: Hargreaves (1915) states that there are six segments visible in the female dorsally and that the wax plates originate from the second. From the figure given by him, it appears that he has not taken into consideration the peduncle. The latter (the attachment between the thorax and the abdomen)

is nothing but the first abdominal segment rather differently formed. It cannot be called the intersegmental membrane between the abdomen and the thorax, because the postnotum of the metathorax generally forms the intersegmental membrane between the thorax and the abdomen and that is well developed. Thus there cannot be a second intersegmental membrane. Further the peduncle appears to have definite tergum, sternum and pleurae and has thus the structure of a segment (Pl. VIII, fig. 1). Accordingly the wax plates begin on the third segment. Dorsally eight segments in all can be made out very clearly in the female.

This work was done under the guidance of Dr. C. B. Williams, and my thanks are due for all the help I received from him.

Method and Technique.

To study the internal structures, adults and larvae were dissected in 5% salt solution, being sometimes washed with ether before dissection to remove the wax. Of the various killing and fixing agents Carnoy's Fluid always gave good results. For staining purposes haematoxylin (Delafield) and eosin were used. For skeletal structures and mounting the larval stages, specimens were boiled in 10% caustic potash for about a quarter of an hour or sometimes kept over-night in cold caustic solution and washed thoroughly before examination.

For studying the tracheal system of the larva De Faure's mounting medium was made use of as recommended by Imms (1929, *Bull. Ent. Res.*, **20**). This is very useful, in mounting larvae, but not for winged adults, as the fluid contains distilled water and air bubbles are liable to be enclosed in the wings as soon as the cover slip is placed in position. Moreover, as the specimens cannot be pressed for fear of damaging the tracheal system, these bubbles are difficult to get rid of.

In order to study the internal structures, microtome sections were taken which were stained with haematoxylin (Delafield) superimposed by eosin.

External Anatomy.

A. brassicae (Pl. VI, figs. 1 to 12.)

Early Stages.

Egg: Elongate, oval, more or less curved on one side with a definite tip and a small stalk on the other side, nearly attached in the middle. When freshly laid, they are shining pale yellow with the orange bodies (the pseudo-vitellus or mycetoma) prominently seen towards the stalk side. The colour after five to seven days changes to brown and then to dark brown. The egg then becomes opaque. The egg, without the stalk, is on an average ·32 mm. long × ·14 mm. broad. The length of the stalk is ·023 mm. The egg when laid is covered with a white powdery meal and hatching takes place by a longitudinal crack.

Larva, 1st instar: The larva as it is seen coming out of the egg-shell is pale white, but when it completely emerges it is pale yellow. Its size is ·33 mm. × ·16 mm., or nearly the size of the egg. Shape elongate more or less oval. If examined soon after emergence, the abdominal segments can be clearly seen but not so the thoracic ones. There is a central dorsal prominence extending from the abdominal segments downwards to the vasiform orifice. There is a rim-like narrow margin from which 16 pairs of small hairs arise, of which one anterior pair and two posterior pairs are prominent and long.

After emergence, the larva remains active for three days. Wax is secreted and the minute particles accumulate and become attached to the marginal hairs so that the larva appears to be moving through some floury material. After the larva has settled down, the colour becomes brownish-yellow, and all over the margin a white waxy fringe is formed. The larva becomes convex dorsally.

Antenna: Comparatively long, slender, and setaceous, pale yellow and consisting of three segments. The basal segment is stout, short and broad at the base. The second segment is longer than the first and has a spine in the middle. The third and the last segment is the longest and ends in a fine point. It has a spine towards the distal third.

Rostrum: A very short, lobed structure situated between the front pair of legs. Two pairs of stylets corresponding to the mandibles and maxillae are present.

Legs: All the three pairs of legs consist of five segments. The coxa is small, stout and ring-like. It has one spine on the inner side. The first and the last pair have their coxae rather farther apart than those of the middle legs. The trochanter is small. The femur is the longest segment. The tibia has one spine in the middle. The tarsus is small and two-jointed. It has one spine on the first segment.

Vasiform orifice: More subcircular than subcordate. The flap-like operculum and the lingula are very prominent in the larvae on leaves. The vasiform orifice is nearer to the caudal margin and is comparatively larger than in later instars. The dorsum of the larva is smooth and devoid of any hairs or spines.

2nd instar: Size ·53 mm. × ·33 mm. Shape more or less oval. Marginal fringe of wax broader and thicker than in the previous instar. Colour of living larvae oily yellow, translucent, but when older, a little brownish. The thoracic segments are not yet so clearly seen as the abdominal ones with the median abdominal ridge. Dorsum smooth, vasiform orifice subcordate, the lingula prominently seen with the two spines at the distal end. Marginal hairs, seen in the first instar when it was active, have disappeared except the two pairs on the caudal end and one pair on the cephalic end.

3rd instar: Size ·7 mm. × ·5 mm. varying up to ·83 mm. × ·58 mm. More or less oval in shape, sometimes the caudal end narrowed into a tail. In freshly moulted specimens the colour is pale yellow, changing to oily yellow and later turning brownish. Dorsum smooth and shining. The marginal fringe of wax sometimes present, sometimes not clearly seen. The thoracic segments still not as clearly seen as those on the abdomen, where there is a central prominent ridge. Margin in mounted specimens crenulate and with a pair of spines at the caudal end. Antennae extremely atrophied. Legs as blunt processes. Eyes appear as small red spots and the rostrum as a lobed structure reaching the middle of the thorax.

4th instar or pupa: Size 1·46 mm. × ·85 mm. Shape more or less oval, colour in freshly moulted specimens pale yellow. In translucent specimens the outline of the developing adult can be clearly seen bordered by a white line. The colour after some time changes to deep yellow and then brown. The chitin then hardens. Later it becomes covered with dirty white waxy meal. The dorsum shows the segmental rings on the abdomen and also on the thorax. The abdominal ridge in the advanced stage disappears. The flat larva becomes convex in shape. The thick narrow marginal fringe of wax fastens the pupa to the surface of the leaf. Sometimes the pupa is yellowish-brown and sometimes dark brown. The vasiform orifice is prominently yellow with the lingula pro-

truding, the latter with two spines at the tip. The dorsum of the pupa is apparently smooth, but in specimens prepared in potash there are seen small tubercles—two pairs, one on each side of the rostrum, and one or two pairs on the thoracic segments. There is also a pair of spines (one on each side) towards the anterior border of the vasiform orifice. The latter has a rectangular operculum and a spatulate and setose lingula. The margin is crenulate with a pair of long spines at the caudal margin. The vasiform orifice is subcordate in shape with the caudal border prominently notched.

The Adult Female.

Length 1·4 mm. General colour of the body yellow and black mixed or rather more black than yellow. Immediately on emergence from the pupa, the insect is quite soft, delicate, shining and pale yellow in colour. The black colour begins to develop on the body after about five hours. It develops first on the thorax and then it appears on the ventral side of the abdomen and then on the dorsal side. The spots on the wings are the last to appear and in some cases they do not develop till the next day.

Head and its Appendages. (Pl. VII, fig. 1.)

Head : More or less triangular in shape, broadened between the antennae, becoming narrower and flat towards the rostrum. It is carried in such a way that its anterior surface slants ventro-caudally. The vertex is rounded and is divided by a median longitudinal suture. The region in front of this suture known as the frons (Fr.) is bounded by a frontal suture (F.S.) giving rise on either side to strong internal ridges. The frons merges anteriorly into the clypeus (Cl.), and it is at the corners of the fronto-clypeal junction (which is very indistinct) that the front arms of the tentorium are seen to join internally. On either side of the frons (in the genal area) is placed an antenna (Ant.) in the antennal socket (Ant. S.). Compound eyes (C.E.) are placed laterally to the antennae and occupy a large amount of space in the genal area.

Antenna : Long, filiform, pale yellow in colour with the terminal segments pale brownish and consisting of seven segments. The first segment is small, round and cup-shaped. The second is subpyriform in shape, very broad at the tip with an excavation to receive the third. On the body of this segment there are about seven or eight short and stout spines. The third segment is the longest. At the base it is narrow, broadening to nearly half the length. It is constricted slightly in the middle and again broadens towards the tip. The fourth segment is the shortest of the last five. The fifth, sixth and seventh are nearly subequal, the last terminating in a bristle. There are three sensoria on the third, one on the fifth and one on the seventh. The sensoria under high magnification and in section appear like small circular pits in the centre of each of which is seen a papilla encircled by a bunch of small hairs. All the last five segments possess annular rings from which small bristles project. In sections the nerves inside the antennae are very clearly seen. The total length is ·516 mm.

Eyes : Each compound eye is completely divided into two parts by a strip-like projection of chitin. The whole eye and the chitinous projection are hairy. The upper part of the eye is bright red or reddish-brown in colour and consists of small round facets arranged in rows. The diameter of these varies from ·0066 mm. to ·010 mm. each. The lower part of the eye is more brownish in colour and consists of larger facets, the diameter of which varies from ·01 to ·013 mm. each. The facets or ommatidia are so arranged that they appear to

be hexagonal in shape, and in stained specimens there is always one unstained facet surrounded by six stained ones (Pl. VI, fig. 2). In sections the wall of the stained lenses is seen thicker than that of the unstained ones. In his recent researches in the study of the Aleurodid eyes, Dr. Eltringham has not come to any definite conclusion regarding the difference in the ommatidia. The upper part of the eye is rectangular in shape and stands on one angle in the middle of the lower portion which is semicircular in shape. Anteriorly to the upper portion of the eye and almost touching it in the middle is placed a single ocellus, elliptical in shape and having the diameter of ·017 mm. In stained specimens, it is pale yellow in colour and not easily noticeable. The ocular sclerite surrounding the eye is strongly developed on the ventral side.

Mouth-parts. (Pl. VII, figs. 1, 2 and 3.)

The mouth-parts consist of (1) clypeus (2) labrum or upper lip, (3) 2 pairs of setae and (4) labium or lower lip.

Clypo-labrum: To the distal end of the frons is the clypeus (Cl.) which further merges into labrum, and so the whole broad trapezium-shaped portion after the frons is called the clypo-labrum. Below this is a triangular-pointed sclerite which may be called the labrum (Lbr.). This has been called by Quaintance and Baker (1913) the epipharynx. The inner floor of this part can be rightly called the epipharynx as it forms part of the endoskeleton. By the side of the clypeus laterally are two sclerites which are known as the clypeal sclerites or lorae (Lo.). The clypo-labral portion and the labrum cover about one-third portion of the labium.

Setae: Behind the labrum are situated two pairs of setae. The anterior pair are the mandibles and the posterior ones the maxillary setae (Md. and Mx.). Each seta consists of a hollow conical expanded basal portion and a long slender portion terminating in a point which constitutes the piercing stylet (Sty.). The basal portions of the setae are contained within the head, but the long piercing stylets pass out through the buccal cavity and become lodged in a groove on the anterior face of the labium which they traverse to the tip. The mandibular setae are free throughout their entire length and are somewhat stouter in build than the maxillary ones. The latter, as they pass out in the buccal cavity, approach the median line until they become closely applied to one another so as to form a single piercing organ. However, the union is one of juxtaposition as they can be easily separated except at the tip where they are more firmly united. By joining the grooves of the two setae a tube for suction is formed. The basal portions of the maxillary setae, and possibly also of the mandibles, are attached to the chitinous walls of the head by rods known as the maxillary levers (Mx. L.).

Labium (fig. 2): The labium is inserted in the base of the head on what is known as the projection of the thorax. It consists of three joints, is bent strongly caudad and appears to be grooved throughout its length. At the base the groove (R.g.) is wide, but more centrally it becomes narrower. The first or the proximal (I. Seg.) is much the longest and narrow and posteriorly has a chitinous rod (C.A.) attached to it. The second segment (II. Seg.) is thicker and shorter. The third segment (III. Seg.) is longer than the second, heavily chitinised and tapering towards the tip. At the extremity of the distal joint, the walls of the fold close almost completely over, but the rest of the groove is open. All the segments are covered with small setae and especially the tip of the third or distal segment. Behind the head there is a short, distinct neck which is attached to the thorax by the sclerotised membrane.

Thorax. (Pl. VII, figs. 4 to 8.)

This is the broadest part of the body. The prothorax and metathorax are comparatively smaller and the mesothoracic region is the largest. In the whole of the insect body the thoracic region both ventrally and dorsally is the darkest.

Prothorax (P.T.) : The smallest segment of the thorax. The notum is dark in colour and collar-like in form. Its anterior border has three semicircular notches—the middle one being the largest and the two side ones being small. The tergum or notum is narrowed mesally but widens, is rounded and also extends laterally downwards till it approaches the pleuron. In the tergal region the parts—prescutum, scutum, scutellum—are not separated. The posterior border of the notum overlaps the anterior border of the prescutum of the mesothorax (Taylor (1918) says that it scarcely overlaps the mesothorax). The pleuron of the prothorax is much reduced and closely attached to the notum. The episternum and the epimeron are not distinguishable. The sternal region consists of only one small sclerite in the centre, the posterior border of which extends to both the coxal bases.

Mesothorax (M.T.) : The notal region is subdivided into several parts (1) prescutum (P. Sc.), (2) scutum (Sc.), (3) scutellum (Scl.) and the postscutellum or postnotum (P.N.).

Two distinct longitudinal sutures which approach behind in the middle of the tergum mark out a portion nearly subcordate in form which is known as the prescutum. Posteriorly and at each side is an ill-defined region forming the major part of the tergum which is known as the scutum. On both sides of the prescutum and anteriorly to the scutum there are two lobed structures which are the pre-alares (P.a.). They connect the notum with the pleuron anterior to the wing. A broken suture nearly parallel with the posterior margin of the notum demarks the scutellum. The posterior border of the latter is produced on either side to a point which connects with the anal margin of the wing. Just before this point, embedded in the membrane, is a small triangular plate articulating with the basis of the anal veins. The postnotum consists of the middle subcordate piece and the postnotal plates one on each side.

The mesopleuron is marked by a pleural suture extending from the wing-base to the articulation of the coxa. The suture starts from the lower pre-alar lobe in a diagonal direction dividing the pleuron into the triangular episternum (E. St.) and an irregular-shaped epimeron (Em.). Above the epimeron at the base of the wing occur two plates known as the sub-alares which support the anal region of the wing. The sternum consists of two oval sclerites jointed together at the base. It is the furca-sternite (F. St.) laterally from which are given out two furcae having a common stalk.

Metathorax (Me. T.) : In the notal region the prescutum is but a very narrow band and is concealed under the postnotum of the mesothorax. The scutum is arched in the middle to receive the conical postnotum of the mesothorax. The scutellum is a small ill-defined region. The posterior margin extends on both sides bearing the axillary cord which is continuous with the anal margin of the wing. The postscutellum is a plate of half the size of the scutum, stretching parallel to the scutellum. The metathorax bends rapidly downwards posteriorly.

The pleural suture is distinct, dividing the pleural region into episternum and epimeron. The suture extends over the entire coxa marking off the vera-coxa (V.C.) and the meron. The coxa is apparently fused with the pleuron.

The sternum consists of one crescent-shaped sclerite called the furca sternite.

Laterally two small furcal processes and a plate (fig. 8) placed vertically are given out.

In living specimens the whole of the thorax is a mixture of black and yellow. On the mesotergum a dark patch is seen on the pre-alares, part of the scutum on both sides and to some extent on the prescutum, in such a way that it assumes the form of a crescent or more exactly a horseshoe, the two arms facing the metathorax. Signoret in his "Essai Monographique sur les Aleurodes" describes the form as "fer a cheval." The black mark on the metathorax is also of the same form, but it faces the one on the mesothorax. The meso-postnotal portion sometimes has only the borders dark. The postscutellum of both the thoraces are yellow, and the pleurae are spotted black and yellow. The sternites are black, and the intersegmental membranes yellow.

Wings: There are two pairs of wings which are rounded on the outer side. They appear white with the powdery wax which covers them, but immediately on hatching they are pale, translucent yellow and delicate. The veins in the wings are of the same colour. As soon as dark colour develops on the body, the veins (especially *Rs*) assume a dark tinge and also the black spots begin to develop. The anterior or the mesothoracic pair is larger, and the posterior or the metathoracic pair smaller, the former measuring 1·8 mm. × ·75 mm. and the latter 1·4 mm. × ·64 mm. The expanded wings cover 3 mm.

Wing-venation.

In freshly emerged specimens we find in the fore-wing—(1) costa, (2) R_1, (3) *Ru*, (4) spur of media and (5) cubitus. (According to Miss Patch, the subcosta is suggested by a faint line.) But after the wing hardens, only (1) costa, (2) *Rs* and (3) cubitus persist—R_1 and median spur disappear. Even the cubitus is only suggested by a faint line. The *Rs* is bent twice, once in the middle from where R_1 is seen to emerge and again towards the end. At each of the bends a black patch is seen to develop soon after the vein *Rs* darkens. These patches appear as irregular patterns of dark lines. In the hind-wing only one vein is present and that is the *Rs* centrally situated. It has one dark area in the centre.

The wings are attached to the meso- and meta-notum respectively by the notal processes and supported from underneath by the pleural processes. Between the veins there occur sclerites known as the axillary sclerites. In the fore-wing there are two small axillary sclerites (Ax. Scl.) above the anal vein, while in the hind-wing there is only one.

Compared with the size of the insect the wings appear to be large. In the sitting posture they are held like a flat roof, and the hind-wings are hidden under the front ones. The wing-borders are orange coloured and beaded. These beads are blunt teeth-like projections from which small hairs are seen to issue. These beads are about 16 to 17 in ·1 mm. The hind-wings have six or seven small hairs on the anterior border near the base.

Legs: Long, thin and spotted with black except at the joints. The coxa (Co.) of the prothorax is large. The distance between these coxae is greater than the other two pairs. The middle coxae are somewhat thinner. The hind ones are very close to each other and are large. The trochanters (Tr.) small and more or less yellow. Femurs (Fe.) proportionately thin and long. Tibiae (Ti.) very thin and long with a double row of small spines which are more numerous on the hind ones. Tarsi (Tar.) two-jointed, the first being the longer. To the distal end are attached two strong claws (Clw.) which enclose between

them a hairy, blade-like empodium or the paronychium (Pa.) the homology of which has been discussed in the introduction (Pl. VIII, figs. 4 to 7).

Abdomen. (Pl. VIII, figs. 1 and 2.) It is spindle-shaped, thick in the middle and tapering both ways, and is attached to the thorax by a peduncular attachment which has already been shown to be the first segment (p. 119). The second segment is comparatively small dorsally, but has a larger sternite, on the dorsum of which there are chitinous rods. The third and fourth segments are comparatively the largest. The subsequent segments become smaller until the last which is large and has a peculiar structure. There are in all eight segments. The wax plates are situated ventrally on the third and fourth segments and cover an area of ·33 mm. × ·25 mm. As Hargreaves (1914) has not taken into consideration the peduncle, he says that wax plates are on the second and third segments. On the tergites there are black stripes commencing from the fourth segment, and these become deeper and larger posteriorly until the last segment which is black both ventrally and dorsally. Dorsally in the middle of the last segment is the vasiform orifice. Behind this the eighth tergite is folded (C.F.) transversely on itself and to the end is attached the basal sclerite (B. Scl.) which supports the dorsally situated genital valves.

Genitalia (fig. 2) : These consist of three pairs of valves which according to their position may be referred to as the ventral, dorsal and inner valves. The ventral valves (V.V.), which are homologous with the coxites of the eighth abdominal sternum, occupy a ventro-lateral position. They are deeply concave on their inner surface. Behind and dorsal to the ventral valves are situated the dorsal pair of valves (D.v.). The latter consist of a pair of chitinous rod-like thickenings which terminate distally into a pair of pointed processes. The region between the dorsal valves is occupied by a thin membrane as the intravalvular membrane (I.V.M.). The inner pair of valves (I.V.) are situated in the distal region of the intravalvular membrane (between the dorsal valves). They consist of a pair of rod-like thickenings lying in the intravalvular membrane and being slightly free at their distal end. The dorsal and ventral valves show a few hairs scattered at their outer surfaces. Much discussion has been taking place as to the homology of the dorsal valves (Imms 1931), but all seem to agree upon their origin from the ninth abdominal sternum. The dorsal and ventral valves are very pointed and together form the ovipositor (Ov.).

The Adult Male.

Generally more slender. Length 1·65 mm. with claspers. Fore-wing 1·45 mm. and hind-wing 1·16 mm. Abdomen strongly pedunculate. The second segment is rather larger. The succeeding segments smaller and tapering. The last segment is collar-like, strongly chitinous and dark in colour. To the distal end of this are attached the claspers. In the male nine segments can be made out very clearly. The last segment is ·15 mm. long and the length of the claspers is ·16 mm. The latter are deeply forked at the tips which possess some hairs. The abdomen has four pairs of waxplates placed ventrally and begin from the third segment. The area occupied by the waxplates is ·27 mm. × ·13 mm. The antenna measures ·588 mm. The legs are similar in structure.

Genitalia. (Pl. VIII, fig. 3.) They consist of a pair of claspers and the medially situated penis or aedeagus. Claspers (Cla.)—otherwise known as parameres—were considered by many authors to be separate processes, but George (1929) does not regard them as distinct entities but as processes of

the aedeagus (Ae.), and as such the aedeagus or the penis is the representative of the endopodite of the ninth segment. If comparison is to be made, the claspers and the aedeagus correspond to the inner pair of valves of the female.

A. lonicerae.

Egg : Elliptical in shape, colour whitish, size ·25 mm. × ·08 mm. without the stalk which is ·03 mm., standing erect; base broad and tapering towards the tip.

1*st instar* : Shape and structure as that of *A. brassicae.* Size ·35 mm. × ·16 mm. Colour olive-yellow.

2*nd instar* : Size ·5 mm. × ·3 mm. Colour olive-yellow. Shape as in that of *A. brassicae.*

3*rd instar* : Size varying from ·61 mm. to ·70 mm. × ·45 to ·50 mm. Shape and structure the same as in *A. brassicae.*

4*th instar* : Size 1·05 mm. × ·73 mm. Shape, structure and habits as in *A. brassicae.*

Two kinds of pupae have been found, one having the dorsum apparently smooth, and the other with six pairs of spines on the dorsum. The position of these spines is as follows :—one pair by the side of the base of the rostrum; second, third and the fourth on each of thoracic segments respectively; the fifth on the first abdominal segment and sixth to the sides of the anterior border of the vasiform orifice. The hairy and smooth pupae are found respectively on hairy and smooth leaves. The adults which hatch out from the two pupae are identical. The colour of the pupa is olive-yellow. In some of the specimens the submarginal area is broader and striated.

Adult ♀: In general similar in structure to *A. brassicae* except that the fore-wings have only one V-shaped black mark on the second flexure in *Rs.* The thorax, head and other parts are dark coloured as in *A. brassicae* except that in *A. brassicae* the meso- and meta-thorax have horseshoe-shaped black marks, while in this species the mesothorax or mesonotum is completely dark excepting sometimes the triangular postnotum. . The bars on the dorsum of the abdomen in *A. brassicae* are not so dark. The adult is smaller in size measuring 1·33 mm. Fore-wing 1·8 mm. × ·72 mm. The rest of the structure is similar to that in *A. brassicae.* Antenna is ·479 mm.

In this species there are also specimens which are quite yellow without any dark colour on the body except one black mark on the wings. But there is no difference in the general structure.

Male : similar to the female except that it is smaller.

T. sonchi.

Egg : Size ·25 mm. × ·07 mm. Colour greenish-yellow. Broadened towards the tip. Shape subelliptical; standing erect on stalk.

1*st instar* : More resembling the larva of *T. vaporariorum*; colour greenish-yellow; size ·283 × ·16 mm.; shape, structure and habits like that of *A. brassicae.* Vasiform orifice subcordate in shape; the caudal end slightly notched. Anterior border of the orifice deeply arched. Lingula spatulate, the tip having a large number of hairs.

Pupa : Size varying from ·75 to ·82 mm. × ·50 to ·62 mm. Shape oval at the surface. Opaque, greenish or yellowish waxy in colour, raised on a palisade of wax. Dorsum smooth. The margin all round has white, shining waxy rods varying in number from 40 to 45 pairs, one caudal and one cephalic pair being the longest. Vasiform orifice subcordate and yellow in colour. Lingula spatulate possessing a pair of spines at the tip. A deep furrow from

the vasiform orifice to the caudal margin. Margin of the case crenulate under the waxy rods.

Adult ♀: Size 1·3 mm. to 1·4 mm. Colour lemon-yellow in general and more so on the thorax. The antennal tips brown. The body structure is the same as in *A. brassicae*. The second segment of the abdomen on the dorsum has a dark border, and the last segment is dark ventrally. Wings white, spotless. Rostrum long, reaching the middle of the abdomen, black at the tip.

Adult ♂: Similar to the female except that it is slender and small. Abdomen strongly pedunculate. The last segment of the abdomen collar-like, dark. The claspers are also dark. The tip of the latter is not forked.

Internal Anatomy.

Reproductive System: This can be traced in two ways, (1) by dissecting the abdomen ventrally by cutting open at the waxplates, or (2) by separating and pulling out the last abdominal segment. This latter is more easily done in the case of males where it is collar-like, but the normal position of the organs becomes disturbed. In the case of females, it is always better to take specimens that are not gravid because the ovarioles discharge the eggs in the act of dissection.

Male Reproductive System of A. brassicae. (Pl. IX, fig. 4.)

This lies ventrally in the last part of the abdomen and consists of the following parts:—(1) Testes (Te.) (2) Genital ducts—(*a*) Vasa deferentia (V.d.), (*b*) Vasiculae seminalis (V.s.), (3) Accessory glands (A.g.), (4) Intromittent organ aedeagus or penis (Ae.).

The testes (Te.) are paired bodies more or less round. Each has a slight constriction towards the distal end with a definite neck. The colour is dull yellow. To the posterior end behind the neck is attached a narrow canal, the Vas deferens (V.d.), which is very short and of a pale yellow colour. This becomes enlarged along its course to form a sac or vesicle. The two vesiculae (V.S.) open into a common passage which leads to the intromittent or copulatory organ. At this point of junction of the two vesiculae is seen a pair of glands known as Accessory glands (A.g.) which are translucent, elliptical bodies one on each side situated between the vesiculae, which are deep yellow with a slight dark tinge. The copulatory organ is narrow at the base but enlarges rapidly and then tapers down into a thin point.

Exactly the same kind of structure is found in *A. proletella* and *A. lonicerae*. In the other three species, *T. sonchi*, *T. vaporariorum* and *A. quercus*, there are great differences in the various parts of the system, of which I give details below (Pl. IX, fig. 3):—

(1) The Testes are globular bodies with a definite tip. They are whitish yellow and have no neck-like constriction.

(2) The Vasa deferentia are very long tubes as compared with those in *A. brassicae*, and are coiled.

(3) The Vesiculae seminales are distinctly smaller than the large sacs in *A. brassicae*, and are pale yellow.

(4) The Accessory Glands are much larger than in *A. brassicae*.

Female Reproductive System of A. brassicae. (Pl. VI, fig. 9.)

This consists of the following parts:—(1) Ovaries, (2) Genital ducts, (3) Spermatheca or Receptaculum seminis.

(1) *Ovaries* (O.) are paired more or less compact bodies lying in the body cavity of the abdomen on either side of the alimentary canal. Each ovary is composed of five egg tubes or ovarioles which open in the oviducts. The ovary is of the acrotrophic type where the epithelial layer grows inward in such a manner as to enclose each oocyte in a sac. In the ovarioles, or the ovarian tubes (O.t.), of this type of the ovary the third zone –the Vitellarium— constitutes the major portion of and contains the developing eggs and the nutrition cells when present. The other two zones—the germarium and the terminal filament—are not well developed. The eggs (Pl. VI, fig. 9) inside the ovarioles are found in different stages of development, the fully developed ones being deep yellow with the chorion having prominent vacuoles. In double stained specimens each egg shows the lining tissue and the nuclei very clearly. That part of the egg (Pl. VI, fig. 10) inside the body which is fully developed is deep red at the point of attachment of the stalk. The stalk of the egg inside the abdomen is always transparent, clear white and directed posteriorly so that when the eggs are laid, the stalk comes out first and the egg is permanently fixed in the plant tissue by embedding the stalk. The number of fully developed eggs at one time in the abdomen is 12 or 13.

(2) *Genital ducts* or Oviducts (O.d.) are paired canals leading from the ovaries and combining to form a common passage. Into the latter opens a globular, flask-shaped organ with a long duct. This is the *Receptaculum seminis* (R.S.). It is a thinly chitinised structure and has pale yellow walls.

The eggs, when fully developed, assume an orange-yellow colour and hence the colour of the abdomen of a gravid female changes to orange on account of the developed eggs inside. The common passage of the oviducts ends in the external genitalia which have been already described.

The female reproductive system is practically the same in all the other five species—*A. proletella*, *A. lonicerae*, *T. sonchi*, *T. vaporariorum* and *A. quercus*.

Digestive System of A. brassicae. (Pl. IX, fig. 2.)

The alimentary canal in insects with sucking mouth-parts or which feed on liquid food is generally longer than in those with biting mouth-parts or which feed on solid food. This holds good of all Homoptera and also in the Aleurodidae. The length of the canal in the latter if straightened measures about 2 mm., while the length of the insect body varies from 1·3 to 1·5 mm. It consists of the three principal divisions :—(1) Fore-intestine (F.I.), (2) Mid-intestine (M.I.) and (3) Hind-intestine (H.I.).

(1) *Fore-intestine* : Made up of three parts—(i) Pharynx (Ph.), (ii) Oesophagus (Oe.) and (iii) Crop (Cp.). If we follow up the canal of the rostrum, the broad portion in the head is the Pharynx which is very well developed. This narrows down in a thin tube, the oesophagus, which passes from the hinder region of the head into the fore part of the thorax. At this point is found a pair of small kidney-shaped bodies, the *salivary glands* (S.g.). The oesophagus leads into a capacious flask-shaped sac, the crop, which occupies a large part of the metathorax. The crop narrows down and joins the next division, the mid-intestine, in the abdomen.

(2) *Mid-intestine* : Also known as the stomach or the mid-gut. It is this part which is coiled and loop-like. Just after the attachment of the crop to the mid-intestine, are two sac-like diverticula which are known as the enteric or gastric caecae (Cae.). The mid-intestine is coiled over itself and is attached to, or near to, the caecae by some thread-like tubules which may be the mal-

pighian tubes. The loop is thick in the middle and greatly decreases in size to the point when it joins the hind-intestine.

(3) *Hind-intestine*: This is also divided into three parts—(i) Small intestine (S.I.), (ii) Colon (Co.) and (iii) Rectum (R.). The first part, which is not very long, narrows posteriorly. The colon is thin-walled, long and coiled. It broadens into the last part, the rectum, which is large in size and oval sac-like in form. It terminates in the anus. The whole system is situated dorsally in the body, and the anus opens dorsally into the peculiar structure called the vasiform orifice which is found on the last segment. The opening of the anus (A.) lies dorsal to the lingula and is protected by the flap or the lid-like covering —the operculum (Op.). The lingula (Li.) is strap-like in form and grooved. It is hairy all over and hence the liquid excreta, as they are thrown out, are directed by means of the channel in the lingula. If we watch the pupae or the larvae, we see that the liquid excreted accumulates in the form of a drop and is then thrown away by a slight jerk of the lingula.

The alimentary system is similar in the other species examined except that the rectum in *sonchi*, *vaporariorum* and *quercus* is more spindle-shaped.

In the larvae of all the species examined, the digestive system is the same as in the adults. In the adults, on account of the structure between the thorax and abdomen, the thin connection between the crop and the mid-gut is often broken, a difficulty that never arises in the dissection of the larvae.

Tracheal System. (Pl. IX, fig. 1.)

Larval: There are four pairs of spiracles (Sp.) present in the body of the larvae. The position of these is as follows:—One pair is situated between the bases of the 1st and 2nd pair of legs, the second pair between the 2nd and 3rd pair of legs, the third below the base of the 3rd pair of legs, and the fourth lies on either side of the vasiform orifice. The first and the fourth pair are the largest. The first, second and fourth pairs can be easily seen, but the third is very difficult to make out.

The tracheal system consists in the main of ventral trunks (V.t.), dorsal girdles (D.g.) and tracheal folds. The ventral trunks run centrally on either side from the anterior to the posterior spiracles. There are two dorsal girdles, the first connecting with each other the first pair of spiracles, and the second with the second pair of spiracles. Besides these, are branches given out from the posterior or anal pair, one going to the sides and the other going upwards parallel to the ventral trunks in the middle. There are also various branches and sub-branches given out from these trunks and ramifying in the cephalic, thoracic and abdominal areas.

The tracheal or breathing folds are the passages between the outside air and the spiracles. The necessity for these organs becomes evident when it is recognised that the spiracles open ventrally and that the body of the larva is cemented to a leaf, so there must be some arrangement for the admission of air, The breathing folds are three in number—a latero-thoracic pair, an anterior pair and one posterior or caudal. Anterior tracheal folds are situated on each side of the thorax communicating with the first pair of thoracic spiracles. The body wall is transversely folded, the fold extending along the sides of the thorax and part of the abdomen. This allows for the access of air to the thoracic and first abdominal spiracles. The caudal fold extends from the vasiform orifice caudad to the margin and forming a Y-shaped structure extending to the posterior thoracic pair of spiracles.

The ventral trunks are stouter and the dorsal ones are thinner. The

tracheal system in the early larvae remains the same in the main parts, and the only difference that is seen is that the ramification of the branches is far less and the tracheal folds are not well developed in the first instars.

Adult: The tracheal system in the adult appears to be more complicated at least in the thorax. There exist four pairs of spiracles—two in the thorax and two in the abdomen. In the former the first pair (Pl. VI, fig. 11) is situated in between the prothorax and mesothorax. The exact position is in the intersegmental membrane just anterior to the first pre-alar lobe. This pair is the largest and is situated on a slight protuberance. The second pair is situated between the border of the mesoepimeron and the metasternum. It is smaller than the first, deep set and not easily noticeable. The third pair, or the first abdominal one, is situated ventrally on the second segment far anterior to the waxplates. The fourth or the last pair (Pl. VI, fig. 12) is situated laterally on the eighth segment, both in the female as well as male, on each side of the vasiform orifice.

As regards the tracheal trunks, two main ones are seen in the abdomen running ventrally, joining the two abdominal pairs of spiracles, and a large number of small and finer branches ramifies from near the spiracles. The part in the thorax (and the finer branches) seems to be complicated and has not been clearly made out.

The spiracles appear to be quite simple and are round holes surrounded by a slightly chitinised rim known as the peritreme. Of the four pairs, that in the prothorax is the largest and the one near the vasiform orifice the smallest. The diameter of the prothoracic and mesothoracic spiracles are ·008 mm. × ·01 mm. and ·005 mm. × ·008 mm. respectively, and that of the caudal pair ·004 mm. × ·006 mm. The latter appears to be surrounded by a ring of hairs bent inwardly.

Bibliography.

Bondar, G. (1923.) Aleyrodideos do Brasil. (Secret. Agric. Ind. Obras publ. Bahia. Seccao Path. Veg.).

Comstock, J. H. (1928.) Introduction to Entomology. The Wings of Insects.

Davidson J. (1914.) On the Mouth Parts and Mechanism of Suction in *Schizoneura lanigera*. J. Linn. Soc. (Zool.), **32**.

George, C. J. (1929.) The Morphology and Development of the Genitalia and Genital Ducts of Homoptera and Zygoptera as shown in the life-histories of *Philaenus* and *Agrion*. Quart. J. Micr. Sci., **72**.

Grove, A. J. (1919.) The Anatomy of the Head and Mouth Parts of *Psylla mali*, with some remarks on the function of the labium. Parasitology, **11**.

Hargreaves, E. (1915.) The Life-history and Habits of the Greenhouse White Fly. Ann. Appl. Biol., **1**: 303–334.

Imms, A. D. (1929.) The Text-book of Entomology.

——. (1931.) Recent Advances in Entomology.

Martin, J. B. (1916.) The Thoracic and Cervical Sclerites of Insects. Ann. Ent. Soc. Amer., **9**.

Quaintance A. L., and Baker A. C. (1913.) The Classification of the Aleurodidae. Part I. Bull. U.S. Dept. Agric. Tech. Ser., **27**.

Signoret, V. (1868.) Essai Monographique sur les Aleurodes. Ann. Soc. ent. Fr., (4) **8**: 369–402.

Snodgrass, R. E. (1928.) The Thoracic Mechanism of a Grasshopper and its antecedent.

Taylor, L. H. (1918.) Thoracic Sclerites of Hemiptera and Homoptera. Ann. Ent. Soc. Amer., **11**.

Woodworth, C. W. (1901.) Respiration of *Aleurodes citri*. Canad. Ent., **23**.

Abbreviations Used.

A. = Anus.
A.g. = Accessory gland.
A.T.P. = Arms of the tentorial pits.
Ab. = Abdomen.
Abd. Seg. = Abdominal segment.
Ae. = Aedeagus.
An. V. = Anal vein.
Ant. = Antenna.
Ant. S. = Antennal socket.
Ax. Scl. = Axillary sclerite.
B. Scl. = Basal sclerite.
C. = Costa.
Ca. = Caecum.
C.A. = Chitinous attachment.
Cae. = Gastric caecae.
C.E. = Compound eye.
C.F. = Chitinous fold.
C.P. = Chitinous process.
C.T. = Chitinous thickening.
Cl. = Clypeus.
Cla. = Clasper.
Clw. = Claw.
Co. = Coxa.
Cp. = Crop.
Col. = Colon.
Cu. = Cubitus.
D.g. = Dorsal girdle.
D.v. = Dorsal valve.
E. = Egg.
E.M. = Epimeron.
Ep. Su. = Epicranial suture.
E. S. = Episternum.
Fe. = Femur.
F.I. = Fore-intestine.
Fl. = Flexure.
Fr. = Frons.
F.R. = Frontal ridge.
F.S. = Frontal suture.
F. St. = Furcal sternite.
Gen. = Genitalia.
H.I. = Hind-intestine.
I.V. = Inner valve.
I.V.M. = Intravalvular membrane.
L. = Larva.
Lb. = Labium.
Lbr. = Labrum.
L.F. = Large facets.
Li. = Lingula.
Lo. = Lorae.
M. = Median.
M.I. = Mid-intestine.
M. St. = Mesosternum.
Md. = Mandible.
Mer. = Meron.
Me. St. = Metasternum.
M.T. = Mesothorax.
Me. T. = Metathorax.
Mx. = Maxilla.
Mx. L. = Maxillary lever.
O. = Ovary.
Oc. = Ocellus.
Oes. = Oesophagus.
Op. = Operculum.
O.t. = Ovarian tubes.
O.d. = Oviducts.
Ov. = Ovipositor.
P. = Pupa.
P.a. = Pre-alares.
Pa. = Paronychium.
Ph. = Pharynx.
Pl. = Pleuron.
Pl. pr. = Pleural process.
P.N. = Postnotum.
P. Sc. = Prescutum.
P. St. = Prosternum.
P.T. = Prothorax.
R. = Rectum.
Ro. = Rostrum.
Rs. = Radial sector.
R.g. = Rostral groove.
R.S. = Receptaculum seminalis.
Sc. = Scutum.
Scl. = Scutellum.
Sen. = Sensorium.
Set. = Setae.
Seg. = Segment.
S.F. = Small facets.
S.g. = Salivary glands.
S.I. = Small intestine.
Sk. = Stalk.
Sp. = Spiracle.
Spr. = Spermatheca.
Sty. = Stylet.
Tar. = Tarsus.
Te. = Testis.
Ter. = Tergum.
Ti. = Tibia.
Tr. = Trochanter.
V. = Vein.
V.C. = Vera coxa.
V.d. = Vas deferens.
V.O. = Vasiform orifice.
V.P. = Ventral plate.
V.s. = Vesicula seminalis.
V.t. = Ventral trunk.
V.V. = Ventral valve.
W. = Wing.
W.P. = Waxplate.
W.A. = Wing-attachment.

Explanation of Plates VI–IX.

Plate VI.

Figs. 1 and 2. Compound eye of *A. brassicae* (photo.). × *c.* 350.
Fig. 3. Compound eye of *T. vaporariorum.* × *c.* 350.
4. Compound eye of *A. azaleae.* × *c.* 350.
5. Compound eye of *A. rubicola.* × *c.* 350.
6. Compound eye of *A. phillyreae.* × *c.* 350.
7. Vasiform orifice of pupa. × *c.* 350.
8. Rostrum of adult. × *c.* 75.
9. Female genital system. × *c.* 150.
10. An egg taken from the body. × *c.* 150.
11. Prothoracic spiracle. × *c.* 350.
12. Spiracle near the vasiform orifice. × *c.*350.

Plate VII.

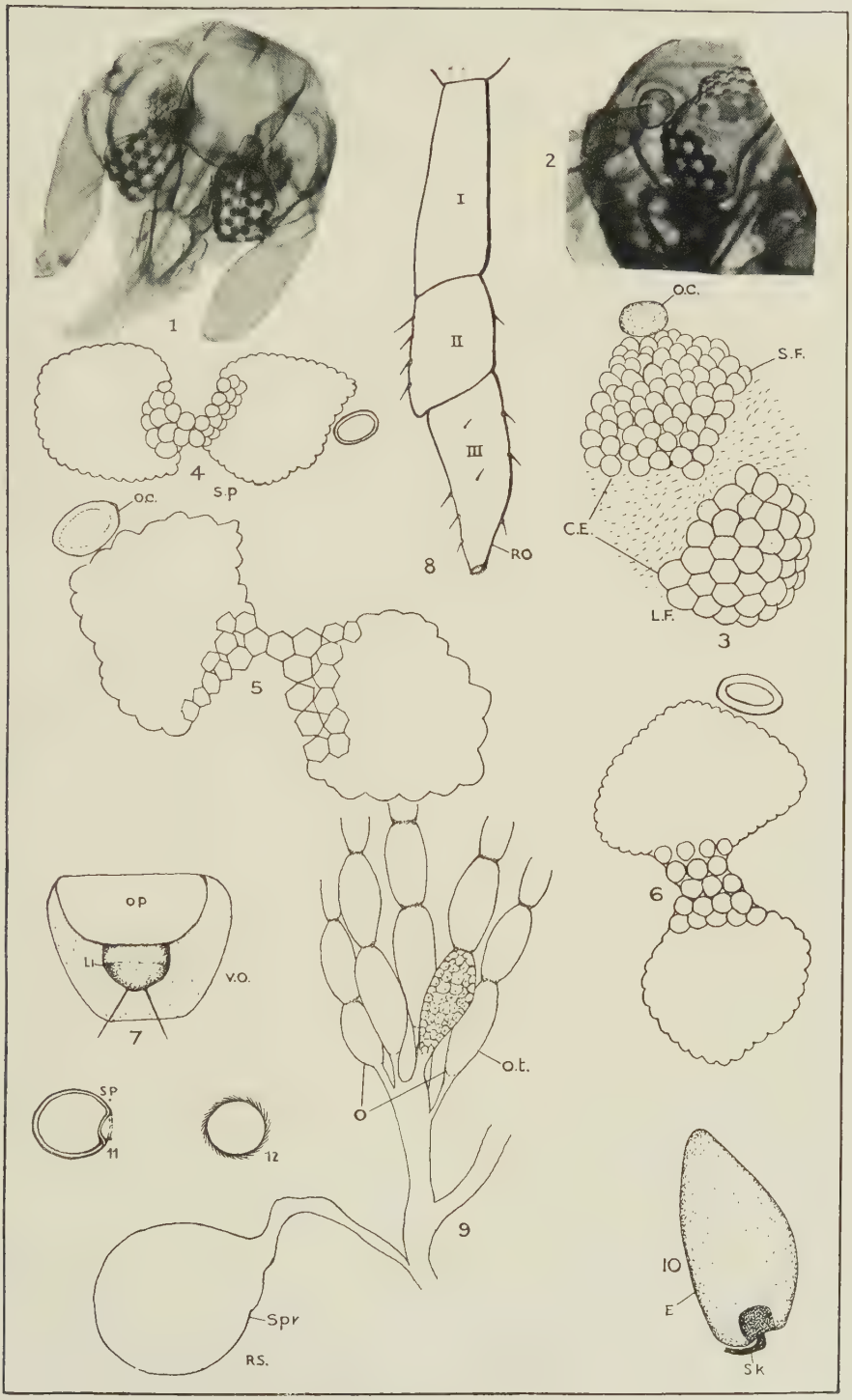
Fig. 1. Head. × *c.* 350.
2. Labium. × *c.* 250.
3. Mandibular and maxillary setae. × *c.* 350.
4. Tergum or notum. × *c.* 150
5. Pleuron. × *c.* 150.
6. Wing-attachment. × *c.* 75.
7. Sterni. × *c.* 150.
8. Vertical chitinous plate of the metasternum. × *c.* 220.

Plate VIII.

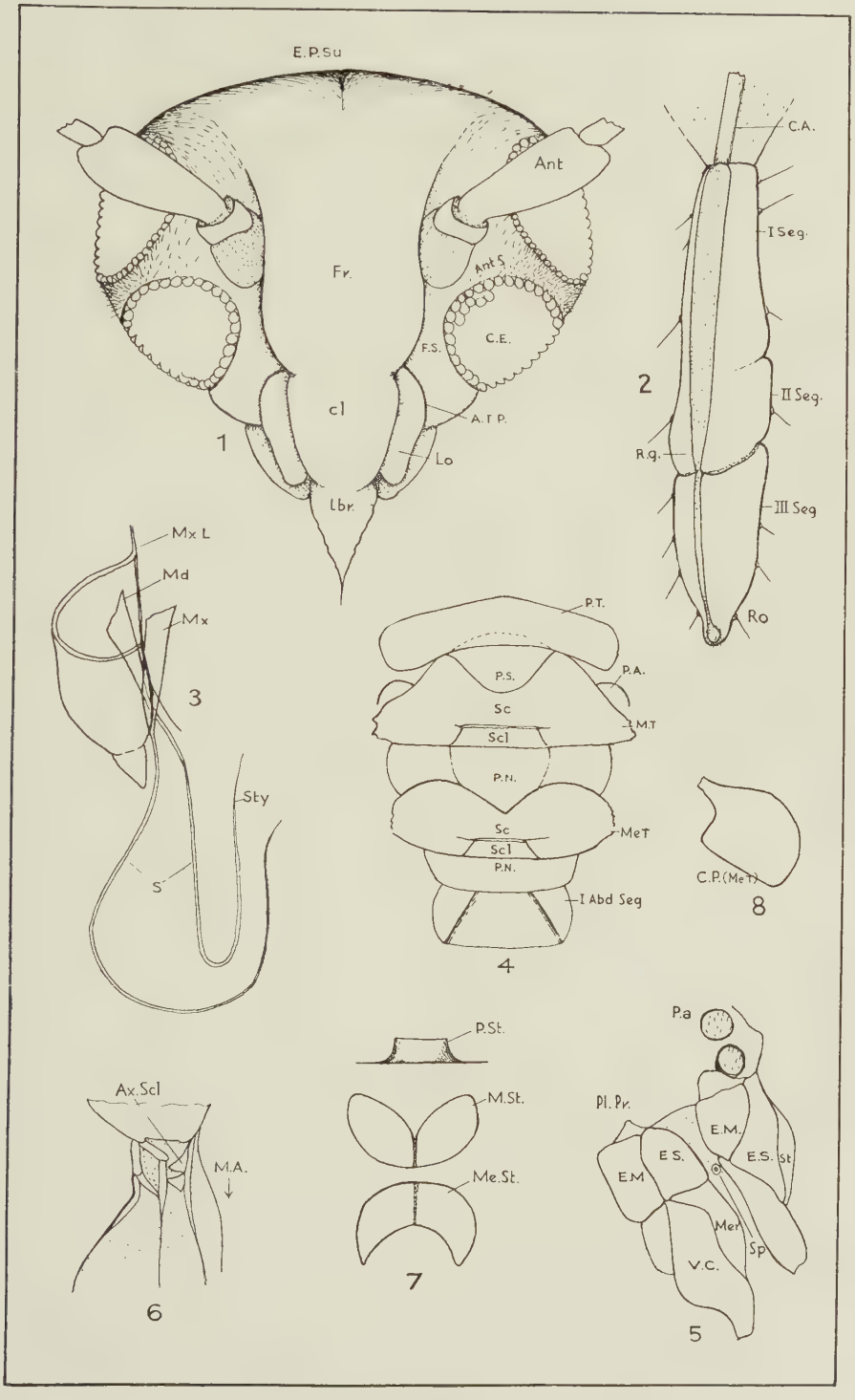
Fig. 1. Female abdomen (dorsal view). × *c.* 220.
2. Female genitalia. × *c.* 350.
3. Male genitalia. × *c.* 350.
Figs. 4 to 6. Pro-, meso- and meta-thoracic legs. × *c.* 75.
Fig. 7. Last part of the tarsus and claws. × *c.* 350.

Plate IX.

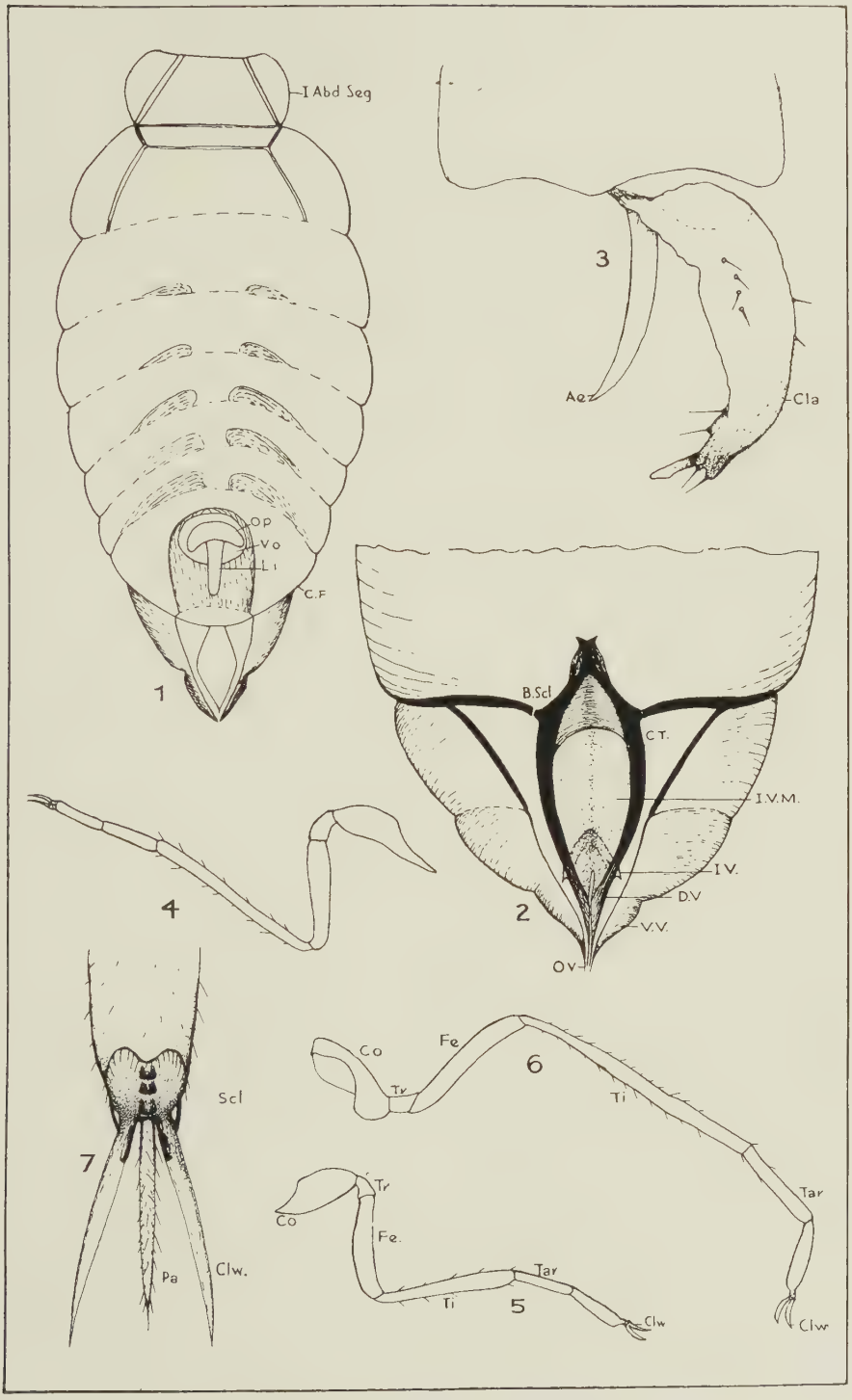
Fig. 1. Tracheal system of a larva. × *c.* 150.
2. Alimentary system of adult. Diagrammatic.
3. Male genital system of *T. vaporariorum.* × *c.* 150.
4. Male genital system of *A. brassicae.* × *c.* 150.



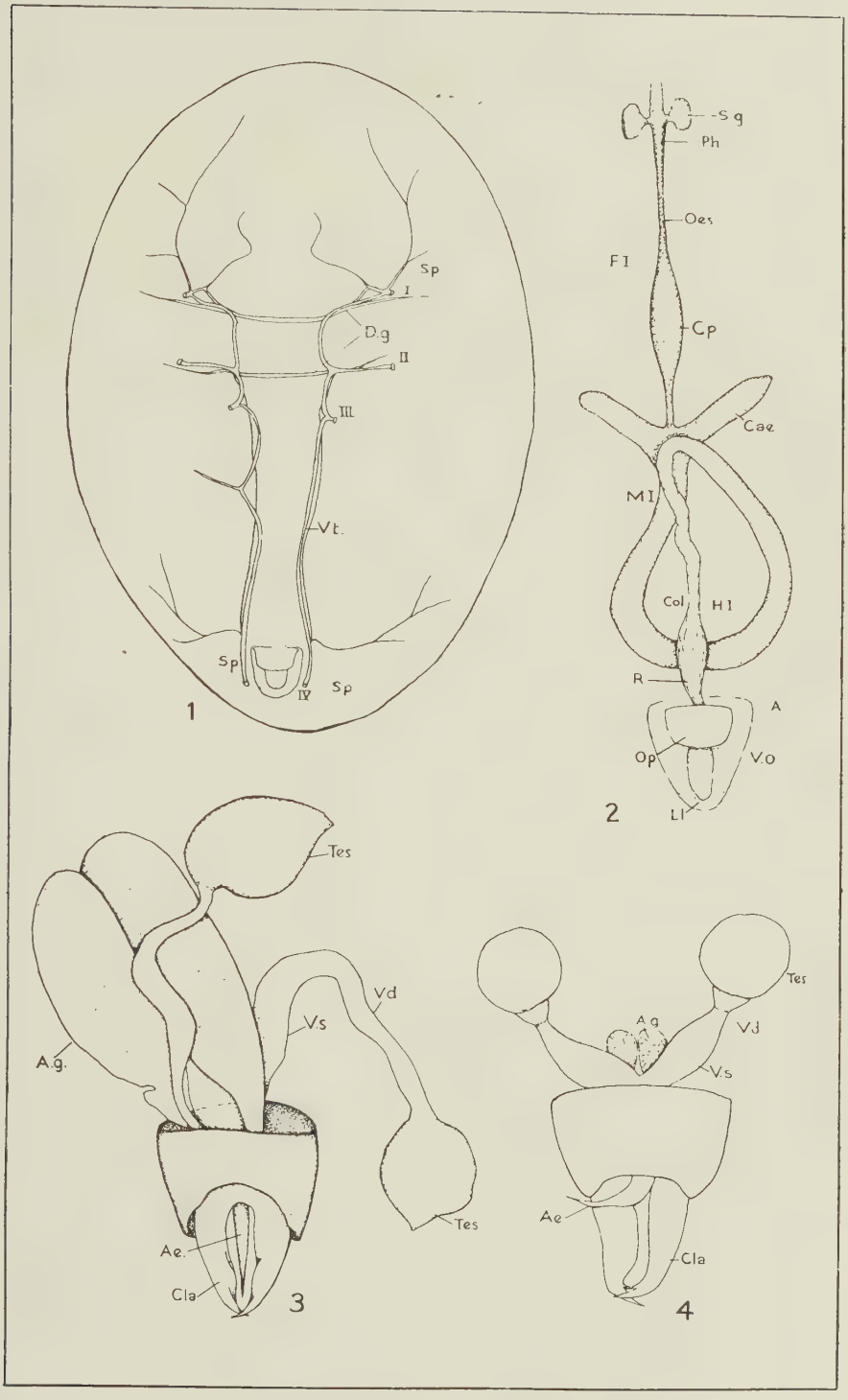
Anatomy of British Aleurodidæ.



Anatomy of British Aleurodidæ.



Anatomy of British Aleurodidæ.



Anatomy of British Aleurodidæ.

THE HYMENOPTEROUS PARASITES OF THE BRITISH LEPIDOPTERA

By Claude Morley, F.Z.S., F.G.S., and W. Rait-Smith, F.Z.S.

[Read 7th June, 1933.]

The following list of the Hymenopterous Parasites of the British Lepidoptera is given in the hope it may be of some practical utility in helping Lepidopterists to name any Hymenopterous parasite they may breed from the larvae or pupae of our native Lepidoptera. By far the greater part of the parasites of our Lepidoptera are Hymenopterous; for such Dipterous parasites as pertain to the family Tachinidae and its allies we must hope some competent Dipterist will ere long accord a similar list. The present compilation attempts to give under each Lepidopteron every British species of Hymenopterous parasite that has hitherto been bred from that species both here and abroad. It will at once be noticed that this list is far from complete, and the Hymenopterous parasites of many species of our Lepidoptera, some quite common ones, are so far unknown to us. We should be very glad to have the Hymenopterous parasites bred from any species of British Lepidoptera, not given in this list, brought to our notice so that as nearly as complete a list as possible may be compiled in due course. Every Hymenopterous parasite given in the present list is a British species.

The outstanding fact brought forward is the curiously indiscriminate nature of Hymenopterous parasitism. So far from the now exploded theory that each parasite is confined to a special host, or nearly so, we find one moth attacked by twenty different kinds of parasites, and on the other hand one kind of parasite having been bred from twenty distinct hosts.

During the past half-century the British parasitic Hymenoptera have been identified so far as such multifarious species and often minute creatures allow of treatment; many thousands of specimens have been both bred by Lepidopterists and named by Hymenopterists, with the result that we have at length come to know with some degree of certainty which of the parasitic families infest Lepidoptera. Though other insect and Arachnid hosts occur in both the Ichneumonidae and Braconidae, parasitism in Lepidoptera is mainly restricted to these two families; a very few of the Proctotrypidae certainly attack their ova and yet fewer Cynipidae have been (in many cases probably erroneously) recorded as parasitic upon their larvae, but it is possible that all such Chalcididae as emerge from them are actually hyperparasites which have slain the direct parasite in the host's body; hence we need consult only the following works to the pages of which reference is made.

Ichneumonidae. Morley, *Ichneumons of Britain*, Vol. 1 (Ichneumoninae), 1903.
" " " Vol. 2 (Cryptinae), 1907.
" " " Vol. 3 (Pimplinae), 1908.
" " " Vol. 4 (Tryphoninae), 1911.
" " " Vol. 5 (Ophioninae), 1914.

Braconidae. Marshall, *in* André, Spec. Hyménopt. d'Europe, Algérie. **4, 5, 5 bis.** *Braconides d'Europe,*
Vol. 1 (1888).
" " " Vol. 2 (1891).
" " " Vol. 3 (1897–1901).

The Lepidopterous hosts have been arranged as far as possible in the order given in South's "Synonymic List of British Lepidoptera." As South's List was published in 1884, the nomenclature has been considerably altered since that date. The names, both generic and specific, given in this List are those used in Seitz, *Palaearctic Lepidoptera*, **1–4**, Tutt's *British Lepidoptera* and Meyrick's *Revised Handbook of British Lepidoptera*, 1928.

Our grateful thanks are due to Dr. K. G. Blair of the British Museum (Nat. Hist.) for information and help with several Lepidopterous hosts and Hymenopterous parasites which were previously unknown.

Note.—The following abbreviations have been used.

I. = Morley, *Ichneumons of Britain.*
B. = Marshall, *Braconides d'Europe.*

The host is placed first, followed by its parasites.

RHOPALOCERA.

Papilionidae.

Papilio machaon, Linn.

Dinotomus lapidator, Fab. I. 1 : 10.
Pimpla aethiops, Curt. I. 3 : 96.
Pelecystoma lutea, Wesm. B. 3 : 135.

Pieridae.

Aporia crataegi, Linn.

Panargyrops aereus, Grav. I. 2 : 105.
Theronia atalantae, Poda I. 3 : 51.
Pimpla instigator, Fab. I. 3 : 93 & 94.
„ *brassicariae*, Poda I. 3 : 110.
Campoplex pugillator, Linn. I. 5 : 79.
Apanteles glomeratus*, Linn. B. 1 : 422.

Pieris brassicae, Linn.

Panargyrops aereus, Grav. I. 2 : 105.
Hemiteles fulvipes, Grav. I. 2 : 123 & 124.
„ *areator*, Panz. I. 2 : 133.
„ *cingulator* Grav. I. 2 : 135.
„ *tristator*, Grav. I. 2 : 148.
„ *melanarius*, Grav. I. 2 : 151.
„ *imbecillus*, Grav. I. 2 : 159.
Pezomachus agilis, Grav. I. 2 : 217.
Pimpla instigator, Fab. I. 3 : 93 & 94.
„ *brassicariae*, Poda I. 3 : 110.
Exetastes nigripes, Grav. I. 3 : 298.
Mesochorus angustatus, Thoms. I. 5 : 335.
Stictopisthus complanatus, Hal. I. 5 : 336.
Apanteles rubripes, Hal. B. 1 : 419.
„ *glomeratus*, Linn. B. 1 : 421.
„ *jucundus*, Marsh. B. 1 : 430.
„ *fulvipes*, Hal. B. 3 : 179.
Pteromalus puparum, Linn. Scilly Isles, bred by K. G. Blair.
Tetrastichus microgastri, Bouché S. Kensington, bred by K. G. Blair.

Pieris rapae, Linn.

Hemiteles fulvipes, Grav. I. 2 : 124.
„ *melanarius*, Grav. I. 2 : 151.
Pimpla rufata, Gmel. I. 3 : 112.
Casinaria ischnogaster, Th. I. 5 : 112.
Stictopisthus complanatus, Hal. I. 5 : 336.
Apanteles rubicula, Marsh. B. 1 : 420.
„ *glomeratus*, Linn. Bred by Clutten at Burnley, in coll. Morley.
Pteromalus imbutus, Waltl. 1876, Proc. Ent. Soc. Lond., **1876** : 35.

Pieris napi, Linn.

Hemiteles melanarius, Grav. I. 2 : 151.
Pteromalus puparum, Linn. S. Kensington, bred by K. G. Blair.

Leucochloë daplidice, Linn.

Anomalon xanthopus, Grav. I. 5 : 245.

Leptidia sinapis, Linn.

Pimpla brevicornis, Grav. I. 3 : 75.

Colias croceus, Fourcr. (**edusa,** Fab.)

? *Charops decipiens*, Grav. I. 5 : 66.

Gonopteryx rhamni, Linn.

Amblyteles oratorius, Fab. I. 1 : 202.
? *Anisobas hostilis*, Grav. I. 1 : 211.
Hemiteles areator, Panz. I. 2 : 133.
Pimpla maculator, Fab. I. 3 : 105.
„ *rufata*, Gmel. I. 3 : 112.

* "Le parasite habituel de tous les papillons du genre *Pieris*." B. 1 : 421.

Limnerium albidum, Gmel. I. 5 : 115.
Anilasta ebenina, Grav. I. 5 : 210.
,, *placida*, Desv. I. 5 : 216.
Mesochorus confusus, Hlgr. I. 5 : 323.
Apanteles gonopterygis, Marsh. B. 3 : 181.
Microdus rufipes, Nees. B. 3 : 193.

NYMPHALIDAE.

Argynnis lathonia, Linn.

Mesochorus brevipetiolatus, Ratz. I. 5 : 331.
,, *anomalus*, Hlgr. I. 5 : 333.
Apanteles spurius, Wsm. B. 1 : 425.

Argynnis aglaia, Linn.

Apanteles vanessae, Reinh. B. 1 : 423.

Argynnis paphia, Linn.

Ctenichneumon homocerus, Wsm. I. 1 : 171.
,, *castigator*, Fab. I. 1 : 172.
Hemiteles melanarius, Grav. I. 3 : 151.

Melitaea aurinia, Rott. **(artemis,** Fab.)

Hemiteles fulvipes, Grav. I. 2 : 124.
Apanteles bignelli, Marsh. B. 1 : 415.
,, *spurius*, Wsm. B. 1 : 425.
,, *zygaenarum*, Marsh. B. 1 : 428.
Meteorus caligatus, Hal. B. 2 : 65.

Melitaea cinxia, Linn.

Apanteles ruficrus, Hal. B. 3 : 177.

Melitaea athalia, Rott.

Stenichneumon culpator, Schr. I. 1 : 42.

Polygonia (Vanessa) c-album, Linn.

Hemiteles melanarius, Grav. I. 2 : 151.
Pimpla brassicariae, Poda I. 3 : 110.
,, *rufata*, Gmel. I. 3 : 112.

Vanessa polychloros, Linn.

Ichneumon extensorius, Linn. I. 1 : 136.
,, *cessator*, Müll. I. 1 : 154.
Theronia atalantae, Poda I. 3 : 51.
Pimpla brassicariae, Poda I. 3 : 110.
Phobocampa unicincta, Grav. I. 5 : 137.

Vanessa urticae, Linn.

Ichneumon extensorius, Linn. I. 1 : 136.
,, *bisignatus*, Grav. I. 1 : 142.
Ctenichneumon haereticus, Wsm. I. 1 : 179.
Orthopelma luteolator, Grav. I. 2 : 112.
Hemiteles fulvipes, Grav. I. 2 : 124.
Pimpla rufata, Gmel. I. 3 : 112.
Phobocampa unicincta, Grav. I. 5 : 137.
Angitia chrysosticta, Grav. I. 5 : 193.
Apanteles congestus, Nees. B. 1 : 413.
,, *rubripes*, Hal. B. 1 : 419.
,, *spurius*, Wsm. B. 1 : 424 & 3 : 178.
? ,, *pallidipes*, Reinh. B. 1 : 479.
Pteromalus puparum, Linn. Scilly Isles, bred by K. G. Blair.

Vanessa io, Linn.

Ctenichneumon castigator, Fab. I. 1 : 172.

Vanessa antiopa, Linn.

Ctenichneumon fossorius, Grav. I. 1 : 175.

Pyrameis (Vanessa) atalanta, Linn.

Ctenichneumon castigator, Fab. I. 1 : 172.
Amblyteles armatorius, Forst. I. 1 : 201.
Pezomachus sp. Scilly Isles, bred by K. G. Blair.
Hemiteles fulvipes, Grav. I. 2 : 124.
Theronia atalantae, Poda I. 3 : 51.
Pimpla instigator, Fab. I. 3 : 94.
Omorga cursitans, Hlmgr. I. 5 : 151.
,, *ensator*, Grav. I. 5 : 154.
Angitia majalis, Grav. I. 5 : 191.
Mesochorus sylvarum, Curt. I. 5 : 327.
Apanteles fulvipes, Hal. B. 1 : 486.
Microgaster subcompletus, Nees. B. 1 : 536.
,, *globatus*, Linn. Scilly Isles, bred by K. G. Blair.
Macrocentrus abdominalis, Fab. B. 2 : 236.

Pyrameis cardui, Linn.

Ctenichneumon castigator, Fab. I. 1 : 172.
Pimpla diluta, Ratz. I. 3 : 68.
Angitia exareolata, Ratz. I. 5 : 203.
? *Bracon variator*, Nees. B. 3 : 85.
Microgaster subcompletus, Nees. B. 1 : 536.
Apanteles emarginatus, Nees. B. 3 : 178.

Limenitis sibylla, Linn.

Theronia atalantae, Poda I. 3 : 51.
Pimpla brassicariae, Poda I. 3 : 110.
Apanteles vanessae, Reinh. B. 1 : 423.

Apatura iris, Linn.

Dinotomus pictus, Kriech. I. 1 : 11.

SATYRIDAE.

Melanargia galathea, Linn.

Ophion obscurus, Fab. I. 5 : 275.

Epinephele jurtina, Linn. (**janira,** Linn.)

Ichneumon extensorius, Linn. I. 1 : 136.
,, *raptorius,* Grav. I. 1 : 153.
Apanteles tetricus, Reinh. B. 1 : 409.
,, *nothus,* Reinh. B. 1 : 437.

LYCAENIDAE.

Zephyrus betulae, Linn.

Campoplex insignitus, Fst. I. 5 : 67.
,, *pugillator,* Linn. I. 5 : 80.
,, *zonellus,* Fst. I. 5 : 90.
Agrypon flaveolatum, Grav. I. 5 : 256.

Thecla w-album, Knoch.

Spilocryptus cimbicis, Tsch. I. 2 : 275.
Pimpla inquisitor, Scop. I. 3 : 110.
Apanteles triangulator, Wsm. B. 1 : 478.

Bithys (Thecla) quercus, Linn.

Pimpla rufata, Gmel. I. 3 : 112.
Euceros crassicornis, Grav. I. 4 : 281.

Chrysophanus dispar, Haw.

Anilasta ebenina, Grav. I. 5 : 210.
Omorga mutabilis, Hlgr. I. 5 : 146.

Heodes phlaeas, Linn.

Hemiteles phlaeas, Boie. I. 2 : 155.

Celastrina argiolus, Linn.

Listrodromus nycthemerus, Grav. I. 1 : 3.

Agriades coridon, Poda (**corydon,** Schiff.)

Apanteles impurus, Nees. B. 1 : 461.

Polyommatus icarus, v. Rott.

Apanteles zygaenarum, Marsh. B. 1 : 428.

Cupido minimus, Fuess.

Nemeritis sordida, Grav. I. 5 : 132.
**Angitia aculeata,* Bdg. I. 5 : 187.
Mesochorus confusus, Hlgr. I. 5 : 323.

Aricia medon, Hufn. (**astrarche,** Bergs.)

Anilasta notata, Grav. I. 5 : 209.
Apanteles astrarches, Marsh. B. 1 : 428.

HETEROCERA.

SPHINGIDAE.

Acherontia atropos, Linn.

Trogus lutorius, Fab. I. 1 : 14.
,, *exaltatorius,* Panz. I. 1 : 15.
Protichneumon fuscipennis, Wsm. I. 1 : 20.
Amblyteles palliatorius, Grav. I. 1 : 187.
,, *cerinthius,* Grav. I. 1 : 197.

Herse (Sphinx) convolvuli, Linn.

Protichneumon fuscipennis, Wsm. I. 1 : 20.

Sphinx ligustri, Linn.

Automalus alboguttatus, Wsm. I. 1 : 13.
Trogus lutorius, Fab. I. 1 : 14.
,, *exaltatorius,* Panz. I. 1 : 15.
Protichneumon fusorius, Linn. I. 1 : 17.
,, *fuscipennis,* Wsm. I. 1 : 20.
Pimpla rufata, Gmel. I. 3 : 112.
? *Exochilum circumflexum,* Linn. I. 5 : 230.

* *Angitia aculeata,* Bridg.; Morl. Ichn. Brit., **5**: 187, ♀. The ♂ of this species has been bred as above and given to Mr. Blair. It agrees in every respect with the female, except in having the antennae three-quarters as long as the body, with apices only slightly attenuate; the petiolar spiracles prominent, the sixth and seventh segments discally simple, and the third not broader than long; the apex of metatarsi is infuscate; and the total length just 5 mm.

Bred by C. N. Hawkins from *Cupido minimus,* Fussel., at Tring in Herts on 16 August, 1930. Androtype in coll. Morley.

Sphinx pinastri, Linn.

Protichneumon fusorius, Linn. I. 1 : 17.
„ *pisorius,* Linn I. 1 : 18.
„ *laminatorius,* Fab. I. 1 : 21.
Schizoloma amicta, Fab. I. 5 : 277.
Anomalon ruficorne, Grav. I. 5 : 244.
„ *bellicosum,* Wsm. I. 5 : 246.

Celerio (Deilephila) euphorbiae, Linn.

Coelichneumon liocnemis, Thoms. I. 1 : 36.
Apanteles nigriventris, Nees. B. 1 : 489.

Celerio gallii, Rott. (**galii,** Schiff.)

Trogus lutorius, Fab. I. 1 : 14.
Protichneumon laminatorius, Fab. I. 1 : 21.
Casinaria orbitalis, Grav. I. 5 : 109.
Erigorgus heros, Wsm. I. 5 : 238.

Pergesa (Chaerocampa) porcellus, Linn.

Protichneumon fuscipennis, Wsm. I. 1 : 19.
Banchus moniliatus, Grav. I. 3 : 287.
„ *falcator,* Fab. I. 3 : 289.

Pergesa elpenor, Linn.

Protichneumon fuscipennis, Wsm. I. 1 : 20.
„ *laminatorius,* Fab. I. 1 : 21.
Ophion undulatus, Grav. I. 3 : 279.

Smerinthus ocellata, Linn.

Trogus lutorius, Fab. I. 1 : 14.
„ *exaltatorius,* Panz. I. 1 : 15.
Protichneumon fusorius, Linn. I. 1 : 17.
Amblyteles palliatorius, Grav. I. 1 : 187.
Scolobates auriculatus, Fab. I. 4 : 273.
Paniscus cephalotes, Hlgr. I. 5 : 303.
Microplitis ocellatae, Bch. B. 1 : 499.

Amorpha (Smerinthus) populi, Linn.

Trogus lutorius, Fab. I. 1 : 14.
Protichneumon fusorius, Linn. I. 1 : 17.
„ *laminatorius,* Fab. I. 1 : 21.
Ichneumon deliratorius, Linn. I. 1 : 113.
Amblyteles monitorius, Panz. I. 1 : 193.
Hoplocryptus fugitivus, Grav. I. 2 : 289.
Cryptus obscurus, Grav. I. 2 : 311.
Pimpla instigator, Fab. I. 3 : 94 & 95.
Banchus pictus, Fab. I. 3 : 284.
Schizoloma capitata, Desv. I. 5 : 228.
Paniscus testaceus, Grav. I. 5 : 296.
„ *cephalotes,* Hlgr. I. 5 : 303.
Mesochorus splendidulus, Grav. I. 5 : 306.
„ *pallidus,* Brisch. I. 5 : 330.
Apanteles glomeratus, Linn. B. 1 : 422.
„ *difficilis,* Nees. B. 1 : 434.
Microplitis ocellatae, Bche. B. 1 : 499.
„ *vidua,* Ruthe. B. 1 : 500.

Mimas (Smerinthus) tiliae, Linn.

Protichneumon disparis, Poda I. 1 : 20.
Pimpla instigator, Fab. I. 3 : 94.
Microplitis ocellatae, Bch. B. 1 : 499.

Macroglossum stellatarum, Linn.

Protichneumon fuscipennis, Wsm. I. 1 : 20.
Spilocryptus migrator, Fab. I. 2 : 277.
Apanteles stellatarum, Bch. B. 1 : 490.

Haemorrhagia (Macroglossa) fuciformis, Linn.

Protichneumon fuscipennis, Wsm. I. 1 : 20.

AEGERIIDAE (SESIIDAE).

Aegeria (Trochilium) apiformis, Cl.

Ctenichneumon funereus, Fourc. I. 1 : 174.

Sphecia (Trochilium) crabroniformis, Lewin

? *Ephialtes carbonarius,* Chr. I. 3 : 41.
Meniscus setosus, Fourc. I. 3 : 228 & 230.
? „ *sulcator,* Morley I. 3 : 233.
? *Mesoleius opticus* Grav. I. 4 : 164.
Pyracmon montanus, Htg. I. 5 : 123.
Bracon mediator, Nees. B. 1 : 121.

Synanthedon (Sesia) scoliaeformis, Borkh.

Pimpla examinator, Fab. I. 3 : 100.
Lissonota sulphurifera, Grav. I. 3 : 207.
Meniscus impressor, Grav. I. 3 : 236.

Synanthedon spheciformis, Gerning

Plectocryptus leucopsis, Grav. I. 2 : 9.
Ephialtes manifestator, Linn. I. 3 : 36.
„ *mesocentrus,* Grav. I. 3 : 37.
„ *tuberculatus,* Fourc. I. 3 : 39.

Pimpla roborator, Fab. I. 3 : 57.
Lissonota segmentator, Fab. I. 3 : 222.
Meniscus pimplator, Zett. I. 3 : 234.
Macrocentrus marginator, Nees. B. 2 : 233.

Synanthedon andrenaeformis, Lasp.

Meniscus pimplator, Zett. I. 3 : 234 & 235.
Bracon roberti, Wesm. Princes Risboro', bred by K. G. Blair.

Synanthedon flaviventris, Stgr.

Macrocentrus marginator, Nees. Southsea, bred by W. Rait-Smith.
Ephialtes strobilorum, Ratz. Southsea, bred by W. Rait-Smith.

Synanthedon tipuliformis, Clerck

Ephialtes albispiculus, Morley I. 3 : 42.
Lissonota bellator, Grav. I. 3 : 200.
Meniscus agnatus, Grav. I. 3 : 232.
? *Omorga ensator*, Grav. I. 5 : 154.
Macrocentrus marginator, Nees. B. 2 : 233.

Synanthedon vespiformis, Linn. (**asiliformis**, Rott.)

Ephialtes tuberculatus, Fourc. I. 3 : 39.
Pristomerus vulnerator, Panz. I. 5 : 224.
Macrocentrus marginator, Nees. B. 2 : 233.

Synanthedon myopaeformis, Borkh.

Ephialtes carbonarius, Chr. I. 3 : 42.
Pimpla roborator, Fab. I. 3 : 57.
Meniscus setosus, Fourc. I. 3 : 228.

Synanthedon culiciformis, Linn.

Phaeogenes cephalotes ?, Wsm. I. 1 : 247.
Lissonota cylindrator, Vill. I. 3 : 205.
Meniscus sulcator, Morley I. 3 : 233.
,, *pimplator*, Zett. I. 3 : 234.
Macrocentrus marginator, Nees. B. 2 : 233.

Synanthedon formiciformis, Esper

Gambrus ornatus, Grav. I. 2 : 285.
Pimpla roborator, Fab. I. 3 : 57.
Meniscus pimplator, Zett. I. 3 : 235.
Acaenitus arator, Rossi I. 3 : 260.
Ophion luteus, Linn. I. 5 : 268.
,, *obscurus*, Fab. I. 5 : 275.
Macrocentrus marginator, Nees. B. 2 : 233.

ZYGAENIDAE.

Procris (Ino) geryon, Hb.

Olesicampa fulviventris, Gmel. I. 5 : 165.
Apanteles geryonis, Marsh. B. 1 : 427.

Procris cognata, H.-S. (**globulariae**, Hb.)

Cremastus bellicosus, Gr. Lewes, bred by C. N. Hawkins.
Apanteles ? *geryonis*, Marsh. B. 1 : 427. Lewes, bred by C. N. Hawkins.

Zygaena meliloti, Esper

Apanteles difficilis, Nees. B. 1 : 434.

Zygaena trifolii, Esper

Microcryptus graminicola, Grav. I. 2 : 34.
Hemiteles fulvipes, Grav. I. 2 : 124.
Mesostenus ligator, Grav. I. 2 : 260.
,, *obnoxius*, Grav. I. 2 : 261 *bis*.
Gambrus ornatus, Grav. I. 2 : 285.
Charops decipiens, Grav. I. 5 : 66.
Casinaria orbitalis, Grav. I. 5 : 109.
Apanteles difficilis, Nees. B. 1 : 434.
,, *zygaenarum*, Marsh. B. 1 : 428. (Scilly Isles, bred by K. G. Blair.)

Zygaena lonicerae, Schev.

Pezomachus palpator, Grav. I. 2 : 236.
Casinaria orbitalis, Grav. I. 5 : 109.
Erigorgus fibulator, Grav. I. 5 : 238.
Agrypon tenuitarsum, Grav. I. 5 : 252.

Zygaena filipendulae, Linn.

Hemiteles fulvipes, Grav. I. 2 : 124.
,, *laevigatus*, Ratz. I. 2 : 153.
Pezomachus analis, Fst. I. 2 : 205.
,, *corruptor*, Fst. I. 2 : 225.
,, *instabilis*, Fst. I. 2 : 228.
Mesostenus obnoxius, Grav. I. 2 : 261.
Spilocryptus migrator, Fab. I. 2 : 277.
,, *fumipennis*, Grav. I. 2 : 278.
? *Gambrus ornatus*, Grav. I. 2 : 285.
Cryptus obscurus, Grav. I. 2 : 311.
Pimpla instigator, Fab. I. 3 : 94.
,, *alternans*, Grav. I. 3 : 106.
Charops decipiens, Grav. I. 5 : 66.
Campoplex pugillator, Linn. I. 5 : 79.
Casinaria orbitalis, Grav. I. 5 : 109.
Erigorgus fibulator, Grav. I. 5 : 238.

Agrypon tenuitarsum, Grav. I. 5 : 252.
Rhogas bicolor, Spin. B. 1 : 288.
Apanteles congestus, Nees. B. 1 : 413.
„ *spurius*, Wsm. B. 1 : 426.
„ *zygaenarum*, Marsh. B. 1 : 428.
„ *difficilis*, Nees. B. 1 : 434.

ARCTIIDAE.

Sarrothripus revayana, Scop.

Paniscus cristatus, Thoms. I. 5 : 293.

Erias chlorana, Linn.

Pimpla maculator, Fab. I. 3 : 105.
Glypta ceratites, Grav. I. 3 : 149.
Campoplex insignitus, Fst. I. 5 : 67.
Omorga multicincta, Grav. I. 5 : 156.
Angitia exareolata, Ratz. I. 5 : 203.
Anilasta ruficincta, Grav. I. 5 : 211.
Holocremna argentata, Grav. I. 5 : 220.
Trichomma enecator, Rossi I. 5 : 234.
Agrypon flaveolatum, Grav. I. 5 : 255.
„ *geniculatum*, Hlmgr. I. 5 : 259.
Ascogaster rufipes, Nees. B. 1 : 358.
Eubadizon extensor, Linn. B. 2 : 137.

Hylophila prasinana, Linn.

Pimpla inquisitor, Scop. I. 3 : 63.
„ *examinator*, Fab. I. 3 : 100.
Campoplex oxyacanthae, Boield I. 5 : 74.
Schizoloma amicta, Fab. I. 5 : 227.
Heteropelma calcator, Wesm. I. 5 : 232.
Anomalon ruficorne, Grav. I. 5 : 244.
Agrypon canaliculatum, Hlmgr. I. 5 : 254.
„ *flaveolatum*, Grav. I. 5 : 255.
Macrocentrus abdominalis, Fab. B. 2 : 236.

Hylophilina (Hylophila) bicolorana, Fuess. **(quercana,** Schiff.)

Pimpla examinator, Fab. I. 3 : 100.
Glypta evanescens, Ratz. I. 3 : 169.
Campoplex pugillator, Linn. I. 5 : 79 *bis*.
Anomalon xanthopus, Grav. I. 5 : 245.
Sigalphus caudatus, Nees. B. 1 : 319.

Nola cucullatella, Linn.

Mesochorus vittator, Hlmgr. I. 5 : 329.
„ *anomalus*, Hlmgr. I. 5 : 333.

Roeselia albula, Schiff.

Angitia fitchi, Brdg. I. 5 : 204.

Lithosia complana, Linn.

Apanteles octonarius, Ratz. B. 1 : 470.

Lithosia lurideola, Zinck.

Microgaster globatus, Nees. B. 1 : 541.

Oenistis (Gnophria) quadra, Linn.

Melanichneumon dumeticola, Grav. I. 1 : 76.
Hemiteles fulvipes, Grav. I. 2 : 123.
Pimpla inquisitor, Scop. I. 3 : 63.
„ *instigator*, Fab. I. 3 : 94.
„ *examinator*, Fab. I. 3 : 100.
Apanteles octonarius, Ratz. B. 1 : 470.
Meteorus fragilis, Wsm. B. 2 : 128.
„ *longicornis*, Ratz. B. 2 : 132.

Gnophria rubricollis, Linn.

Cratichneumon sicarius, Grav. I. 1 : 54.
„ *rufifrons*, Grav. I. 1 : 57.
Amblyteles palliatorius, Grav. I. 1 : 188.
Eurylabus torvus, Wsm. I. 1 : 218.

Hipocrita (Euchelia) jacobaeae, Linn.

Melanichneumon saturatorius, Linn. I. 1 : 79.
Hemiteles fulvipes, Grav. I. 2 : 124.
Mesostenus obnoxius, Grav. I. 2 : 261.
Spilocryptus incubitor, Ström. I. 2 : 272.
„ *migrator*, Fab. I. 2 : 277.
Cryptus obscurus, Grav. I. 2 : 311.
Pimpla instigator, Fab. I. 3 : 94.
Erigorgus insidiator, Fst. I. 5 : 237.
Labrorhychus tenuicornis, Grav. I. 5 : 249.
Mesochorus anomalus, Hlmgr. I. 5 : 333.
„ *facialis*, Brdg. I. 5 : 334.
Apanteles difficilis, Nees. B. 1 : 434.
„ *popularis*, Hal. B. 1 : 476.

Callimorpha dominula, Linn.

Protichneumon erythrogaster, Steph. I. 1 : 19.
„ *fuscipennis*, Wsm. I. 1 : 20.
Schizoloma amicta, Fab. I. 5 : 227.
Anomalon ruficorne, Grav. I. 5 : 244.
Ophion ventricosus, Grav. I. 5 : 277.

Diacrisia (Nemeophila) sannio, Linn.

Rhogas dimidiatus, Spin. B. 1 : 283.

Parasemia (Nemeophila) plantaginis, Linn.

Apanteles callidus, Hal. B. 1 : 485.

Arctia caja, Linn.

Stenichneumon trilineatus, Gmel. I. 1 : 45.
Pimpla instigator, Fab. I. 3 : 94.
? *Exetastes nigripes*, Grav. I. 3 : 298.
? *Campoplex falcator*, Fab. I. 5 : 73.
Rhogas geniculator, Nees. B. 1 : 286.
Ascogaster rufidens, Wsm. B. 1 : 359.
Apanteles caiae, Bch. B. 1 : 431.
„ *difficilis*, Nees. B. 1 : 434.

Arctia villica, Linn.

Hemiteles fulvipes, Grav. I. 2 : 124.
Pezomachus tristis, Fst. I. 2 : 219.
Apanteles caiae, Bch. B. 1 : 431.
„ *villanus*, Reinh. B. 3 : 176.

Phragmatobia (Spilosoma) fuliginosa, Linn.

Coelichneumon periscelis, Wsm. I. 1 : 27.
Ichneumon formosus, Grav. I. 1 : 146.
„ *haglundi*, Hlmgr. I. 1 : 148.
Phygadeuon nycthemerus, Grav. I. 2 : 77.
Cryptus cyanator, Grav. I. 2 : 304.
Pimpla examinator, Fab. I. 3 : 100.
Apanteles difficilis, Nees. B. 1 : 434.
„ *fulvipes*, Hal. B. 1 : 486.
„ *vitripennis*, Hal. B. 1 : 489.
Microgaster connexus, Nees. B. 1 : 525.

Spilarctia (Spilosoma) lubricipeda, Linn.

Exetastes nigripes, Grav. I. 3 : 298.
Hepiopelmus maculiventris. Braunton, *teste* K. G. Blair.
Apanteles congestus, Nees. B. 1 : 413.
„ *picipes*, Bch. Hendon, bred by K. G. Blair.

Spilosoma menthastri, Esper

Ichneumon sarcitorius, Linn. I. 1 : 115.
Pimpla instigator, Fab. I. 3 : 94.
„ *rufata*, Gmel. I. 3 : 112.
Apanteles ruficrus, Hal. B. 1 : 410.
„ *nothus*, Reinh. B. 1 : 437.

Spilosoma urticae, Esper

Metopius micratorius, Fab. I. 4 : 6.

Cossidae.

Cossus ligniperda, Fab.

Dicaelotus pusillator, Grav. I. 1 : 276.
Meniscus setosus, Fourc. I. 3 : 228. *cf.* 4 : 127.

Zeuzera pyrina, Linn. (**aesculi,** Linn.)

Copidosoma truncatellum, Dalm. Proc. Ent. Soc. Lond., **1881** : xx.

Limacodidae.

Cochlidion (Heterogenea) limacodes, Hufn. (**testudo,** Schiff.)

Platylabus pedatorius, Fab. I. 1 : 224.
Sphinctus serotinus, Grav. I. 4 : 11.
Petalodes unicolor, Wsm. B. 1 : 266.
Pelecystoma lutea, Wsm. B. 1 : 268.
„ *tricolor*, Wsm. B. 1 : 269.
Meteorus chrysophthalmus, Nees. B. 2 : 67.

Heterogenea asella, Schiff.

Hemiteles necator, Grav. I. 2 : 130.
Sagaritis declinator, Grav. I. 5 : 95.
Phobocampa crassiuscula, Grav. I. 5 : 136.
„ *unicincta*, Grav. I. 5 : 137.

Lymantriidae.

Euproctis (Porthesia) chrysorrhoea, Linn.

Stenichneumon scutellator, Grav. I. 1 : 45.
Theronia atalantae, Poda I. 3 : 51
Pimpla instigator, Fab. I. 3 : 93 & 94.
„ *examinator*, Fab. I. 3 : 100.
Rhogas geniculator, Nees. B. 1 : 286.
Apanteles ultor, Reinh. B. 1 : 445.
„ *inclusus*, Ratz. B. 1 : 472.

Porthesia similis, Fuessl.

Automalus alboguttatus, Grav. I. 1 : 13.
Pimpla instigator, Fab. I. 3 : 93 & 94.
Banchus variegator, Fab. I. 3 : 283.
Mesochorus splendidulus, Grav. I. 5 : 309.
„ *pallidus*, Brisch. I. 5 : 330.
„ *pictilis*, Hlmgr. I. 5 : 334.
„ *facialis*, Brdg. I. 5 : 334.
Apanteles ultor, Reinh. B. 1 : 445.
„ *fulvipes*, Hal. B. 1 : 486.
„ *curvulus*, Thoms. B. 3 : 292.

Microgaster posticus, Nees. B. 1 : 518.
„ *connexus*, Nees. B. 1 : 525.
„ *dilutus*, Ratz. 1879, Ent. Mon. Mag., 15 : 116.

Stilpnotia (Leucoma) salicis, Linn.

Protichneumon disparis, Poda I. 1 : 20.
Idiolispa analis, Grav. I. 2 : 297.
Pimpla inquisitor, Scop. I. 3 : 63.
„ *instigator*, Fab. I. 3 : 93, 94 & 95.
„ *brassicariae*, Poda I. 3 : 110.
Dyspetes praerogator, Linn. I. 4 : 172.
Apanteles solitarius, Ratz. B. 1 : 406.
„ *difficilis*, Nees. B. 1 : 434.
„ *salebrosus*, Marsh. B. 1 : 446.
Meteorus scutellator, Nees. B. 2 : 112.
Pteromalus sp. Enfield, bred by T. R. Eagles.

Laelia coenosa, Hb.

Pimpla aethiops, Curtis I. 3 : 96.

Lymantria (Ocneria) dispar, Linn.

Protichneumon disparis, Poda I. 1 : 20.
Stenichneumon pictus, Grav. I. 1 : 49.
Hemiteles fulvipes, Grav. I. 2 : 124.
„ *bicolorinus*, Grav. I. 2 : 131.
„ *cingulator*, Grav. I. 2 : 135.
Theronia atalantae, Poda I. 3 : 51.
Pimpla instigator, Fab. I. 3 : 93–95.
Casinaria ischnogaster, Thoms. I. 5 : 112.
Omorga difformis, Gmel. I. 5 : 148.
Trichomma enecator, Rossi I. 5 : 234.
Apanteles solitarius, Ratz. B. 1 : 406.
„ *fulvipes*, Hal. B. 1 : 486.
„ *liparidis*, Bch. B. 1 : 491.
Meteorus scutellator, Nees. B. 2 : 112.

Lymantria (Psilura) monacha, Linn.

Automalus alboguttatus, Grav. I. 1 : 13.
Protichneumon disparis, Poda I. 1 : 20.
Coelichneumon sugillatorius, Linn. I. 1 : 24.
Ichneumon raptorius, Grav. I. 1 : 153.
Odontomerus dentipes, Gmel. I. 3 : 11.
Xylonomus irrigator, Fab. I. 3 : 21.
Ephialtes tuberculatus, Fourc. I. 3 : 39.
Pimpla inquisitor, Scop. I. 3 : 63.
„ *instigator*, Fab. I. 3 : 93.
„ *examinator*, Fab. I. 3 : 100.
„ *brassicariae*, Poda I. 3 : 110.
„ *rufata*, Gmel. I. 3 : 112.
Anilasta rapax, Grav. I. 3 : 209.
Apanteles solitarius, Ratz. B. 1 : 406.
Meteorus unicolor, Htg. B. 2 : 132.

Dasychira fascelina, Linn.

Ichneumon bellipes, Wsm. I. 1 : 143.
Banchus falcator, Fab. I. 3 : 289.
Anilasta carbonaria, Ratz. I. 5 : 210.
„ *ebenina*, Grav. I. 5 : 210.
„ *placida*, Desv. Braemar, bred by C. N. Hawkins.

Dasychira pudibunda, Linn.

Automalus alboguttatus, Grav. I. 1 : 13.
Stenichneumon pistorius, Grav. I. 1 : 144.
Cratichneumon fabricator, Fab. I. 1 : 61.
Barichneumon bilunulatus, Grav. I. 1 : 99.
Ichneumon computatorius, Müll. I. 1 : 131.
Hemiteles areator, Panz. I. 2 : 133.
Pimpla instigator, Fab. I. 3 : 93.
Campoplex oxyacanthae, Boield I. 5 : 74.
Phobocampa unicincta, Grav. I. 5 : 137.
Schizoloma amicta, Fab. I. 5 : 227.
Paniscus cephalotes, Hlmgr. I. 5 : 303.
Apanteles triangulator, Wsm. B. 1 : 478.

Orgyia gonostigma, Fab.

Pezomachus cursitans, Grav. I. 2 : 231.
Pimpla instigator, Fab. I. 3 : 93.
Sagaritis incisus, Brdg. I. 5 : 101.
Anilasta carbonaria, Ratz. I. 5 : 210.
Rhogas geniculator, Nees. B. 1 : 286.

Orgyia antiqua, Linn.

Pimpla graminellae, Hlmgr. I. 3 : 60.
„ *inquisitor*, Scop. I. 3 : 63.
„ *instigator*, Fab. I. 3 : 94 & 95.
„ *flavonotata*, Hlmgr. New Forest, bred by K. G. Blair.
„ *arctica*, Zett. I. 3 : 97.
Hemiteles fulvipes, Gr. I. 2 : 124.
Sagaritis raptor, Zett. I. 5 : 97.
Casinaria ischnogaster, Thoms. I. 5 : 112.
Phobocampa obscurella, Hlgr. I. 5 : 138.
Anilasta carbonaria, Ratz. I. 5 : 210.
Mesochorus pallidus, Brisch. I. 5 : 330.
Rhogas geniculator, Nees. B. 1 : 286.
Apanteles solitarius, Ratz. B. 1 : 406.
„ *formosus*, Wsm. B. 1 : 481.
Pteromalus sp. Highgate, bred by K. G. Blair.
Psychophagus omnivorus, Wlk. S. Kensington, bred by K. G. Blair.
Telenomus dalmanni, Gr. Hyde Park, bred by K. G. Blair.

LASIOCAMPIDAE.

Trichiura crataegi, Linn.

Stenichneumon culpator, Schr. I. 1 : 43.
Eupalamus oscillator, Wsm. I. 1 : 72.
Ctenichneumon mesocastanus, Gr. I. 1 : 177.
Eurylabus dirus, Wsm. I. 1 : 216.

Poecilocampa populi, Linn.

Gambrus tricolor, Grav. I. 2 : 283.
Metopius micratorius, Fab. I. 4 : 61.
Agrypon septentrionale, Hlmgr. I. 5 : 257.
Ophion luteus, Linn. I. 5 : 268.
Henicospilus ramidulus, Linn. I. 5 : 281.
Paniscus cephalotes, Hlmgr. I. 5 : 303.
Campoplex sp. Eastbourne, bred by G. V. Bull.
Apanteles difficilis, Nees. B. 1 : 434.
,, *insidens,* Ratz. Portsmouth, bred by E. A. Cockayne.

Eriogaster lanestris, Linn.

Cratichneumon nigritarius, Grav. I. 1 : 58.
Eurylabus dirus, Wsm. I. 1 : 216.
Phaeogenes callopus, Wsm. I. 1 : 261.
Metopius micratorius, Fab. I. 4 : 7.
Ophion undulatus, Grav. I. 5 : 279.
Henicospilus ramidulus, Linn. I. 5 : 281.
Meteorus versicolor, Wsm. B. 3 : 301.

Malacosoma (Bombyx) neustria, Linn.

Hemiteles bicolorinus, Grav. I. 2 : 131.
Mesotenus ligator, Grav. I. 2 : 260.
Spilocryptus abbreviator, Fab. I. 2 : 280.
Gambrus ornatus, Grav. I. 2 : 285.
Cryptus cyanator, Grav. I. 2 : 304.
Theronia atalantae, Poda I. 3 : 51.
Pimpla inquisitor, Scop. I. 3 : 63.
,, *instigator,* Fab. I. 3 : 93–95.
,, *examinator,* Fab. I. 3 : 100.
,, *maculator,* Fab. I. 3 : 105.
,, *rufata,* Gmel. I. 3 : 112.
,, *ornata,* Grav. I. 3 : 116.
Metopius micratorius, Fab. I. 4 : 6.
? *Monoblastus neustriae,* Schr. I. 4 : 285.
Casinaria moesta, Grav. I. 5 : 111.
Erigorgus perspicillator, Gr. I. 5 : 236.
Mesochorus ater, Ratz. I. 5 : 306.
? *Apanteles rubripes,* Hal. B. 1 : 419.
Meteorus scutellator, Nees. B. 2 : 112.
,, *versicolor,* Wsm. B. 2 : 117.

Malacosoma castrensis, Linn.

Erigorgus perspicillator, Gr. I. 5 : 236.
,, *fibulator,* Grav. I. 5 : 238.
Apanteles spurius, Wsm. B. 1 : 426.
Macrocentrus tenuis, Ratz. B. 2 : 240.

Macrothylacia (Bombyx) rubi, Linn.

Amblyteles armatorius, Forst. I. 1 : 201.
Spilocryptus migrator, Fab. I. 2 : 277.
Schizoloma amicta, Fab. I. 5 : 227.
? *Gravenhorstia picta,* Boield I. 5 : 279.
Ophion undulatus, Grav. I. 5 : 279.
Apanteles carbonarius, Wsm. B. 1 : 408.
,, *ordinarius,* Ratz. B. 1 : 412.
,, *difficilis,* Nees. B. 1 : 434.
Telenomus bombycis, Mayr. Byfleet, bred by K. G. Blair.

Lasiocampa quercus, Linn. and var. **callunae,** Palm.

Hemiteles bicolorinus, Grav. I. 2 : 131.
Pycnocryptus peregrinator, Linn. I. 2 : 269.
Spilocryptus migrator, Fab. I. 2 : 276.
Goniocryptus titillator, Linn. I. 2 : 300.
Cryptus obscurus, Grav. I. 2 : 311.
Meniscus impressor, Grav. I. 3 : 236.
Metopius dentatus, Fab. I. 4 : 4 & 5.
,, *micratorius,* Fab. I. 4 : 7.
? *Homocidus elegans,* Grav. I. 4 : 110.
Anilasta rufa, Bridg. I. 5 : 214.
? *Gravenhorstia picta,* Boield I. 5 : 261.
Ophion luteus, Linn. I. 5 : 268.
,, *ventricosus,* Grav. I. 5 : 277.
,, *undulatus,* Grav. I. 5 : 279.

Lasiocampa (Bombyx) trifolii, Esper

Spilocryptus migrator, Fab. I. 2 : 277.
Pimpla examinator, Fab. I. 3 : 100.
Metopius dentatus, Fab. I. 4 : 4 *bis.*
Exochilum circumflexum, Linn. I. 5 : 230.
Gravenhorstia picta, Boield I. 5 : 260.
Ophion undulatus, Grav. I. 5 : 279.

Cosmotriche (Odonestis) potatoria, Linn.

Spilichneumon occisorius, Fab. I. 1 : 183.
Amblyteles subsericans, Grav. I. 1 : 199.
Hepiopelmus leucostigmus, Grav. I. 1 : 209.

Spilocryptus incubitor, Ström. I. 2 : 272.
Gambrus ornatus, Grav. I. 2 : 285.
Pimpla graminellae, Hlmgr. I. 3 : 60.
,, *inquisitor*, Scop. I. 3 : 63.
,, *didyma*, Grav. I. 3 : 72.
,, *instigator*, Fab. I. 3 : 94.
,, *maculator*, Fab. I. 3 : 105.
Glypta flavolineata, Grav. I. 3 : 168.
Anomalon ruficorne, Grav. I. 5 : 244.
Ophion undulatus, Grav. I. 5 : 279.
Rhogas geniculator, Nees. B. 1 : 285.

Gastropacha (Lasiocampa) quercifolia, Linn.

Metopius dentatus, Fab. I. 4 : 4.
Anilasta dolosa, Grav. I. 5 : 212.

Epicnaptera (Lasiocampa) ilicifolia, Linn.

Apanteles difficilis, Nees. B. 1 : 434.

SATURNIIDAE.

Eudia (Saturnia) pavonia, Linn. **(carpini,** Schiff.)

Amblyteles armatorius, Forst. I. 1 : 201.
,, *oratorius*, Fab. I. 1 : 202.
Pezomachus palpator, Grav. I. 2 : 237.
Spilocryptus incubitor, Ström. I. 2 : 272.
,, *fumipennis*, Grav. I. 2 : 278.
Exetastes nigripes, Grav. I. 2 : 298.
Metopius dentatus, Fab. I. 4 : 4. *cf.* 2.
Apanteles immunis, Hal. B. 3 : 179.

DREPANIDAE.

Drepana lacertinaria, Linn. **(lacertula,** Schiff.)

Pimpla rufata, Gmel. I. 3 : 112.
Labrorhychus tenuicornis, Grav. I. 5 : 249.
Apanteles sericeus, Nees. B. 3 : 177.

Drepana falcataria, Linn. **(falcula,** Schiff.)

Hemiteles areator, Panz. I. 2 : 133.
Pimpla rufata, Gmel. I. 3 : 112.
Phytodiaetus coryphaeus, Gr. I. 3 : 244.
Phobocampa crassiuscula, Grav. I. 5 : 136.
Paniscus tarsatus, Brisch. I. 5 : 290.

Drepana cultraria, Fab.

Paniscus tarsatus, Brisch. I. 5 : 290.
,, *virgatus*, Fourc. I. 5 : 292.

Cilix glaucata, Scop.

Rhogas testaceus, Spin. B. 1 : 296.

NOTODONTIDAE.

Cerura (Dicranura) bicuspis, Borkh.

Ichneumon confusorius, Grav. I. 1 : 139.

Cerura furcula, Linn.

Hemiteles areator, Panz. I. 2 : 133.
Pimpla instigator, Fab. I. 3 : 95.
Paniscus cristatus, Thoms. I. 5 : 293.
,, *testaceus*, Grav. I. 5 : 296.
? ,, *cephalotes*, Hlmgr. I. 5 : 301.

Cerura bifida, Hb.

Hemiteles cingulator, Grav. I. 2 : 135.
Spilocryptus migrator, Fab. I. 2 : 277.
,, *abbreviator*, Fab. I. 2 : 280.
Metopius micratorius, Fab. I. 4 : 6.
Ophion luteus, Linn. I. 5 : 268.
Paniscus virgatus, Fourc. I. 5 : 292.
,, *testaceus*, Grav. I. 5 : 296.
,, *cephalotes*, Hlmgr. I. 5 : 303.
Apanteles spurius, Wsm. B. 1 : 426.

Dicranura vinula, Linn.

Melanichneumon saturatorius, Linn. I. 1 : 78.
Ichneumon deliratorius, Linn. I. 1 : 113.
Eurylabus larvatus, Chr. I. 1 : 217.
Spilocryptus migrator, Fab. I. 2 : 277.
Pimpla examinator, Fab. I. 3 : 100.
Phobocampa crassiuscula, Grav. I. 5 : 136.
Ophion luteus, Linn. I. 5 : 268.
,, *obscurus*, Fab. I. 5 : 275.
Paniscus testaceus, Grav. I. 5 : 296.
,, *cephalotes*, Hlmgr. I. 5 : 301.
Apanteles affinis, Nees. B. 1 : 418.
,, *spurius*, Wsm. B. 1 : 426.

Stauropus fagi, Linn.

Eurylabus larvatus, Chr. I. 1 : 217.
Metopius micratorius, Fab. I. 4 : 6 & 7.
Ophion bombycivorus, Grav. I. 5 : 278.
Apanteles triangulator, Wsm. B. 1 : 478.
,, *octonarius*, Ratz. B. 3 : 179.

Pterostoma palpina, Linn.

Protichneumon fusorius, Linn. I. 1 : 17.
Pimpla instigator, Fab. I. 3 : 94.
Pygostolus sticticus, Fab. B. 2 : 169.

Lophopteryx camelina, Linn.

Amblyteles armatorius, Forst. I. 1 : 201.
Campoplex falcator, Fab. I. 5 : 72.
Astiphrommus pictus, Brisch. Gight, Aberdeen, bred by E. A. Cockayne.
Apanteles spurius, Wsm. B. 1 : 426.
,, *difficilis,* Nees. B. 1 : 434.
,, *abjectus,* Marsh. B. 1 : 473.

Pheosia (Notodonta) tremula, Cl. (**dictaea,** Esper)

Apanteles difficilis, Nees. B. 1 : 434.

Pheosia dictaeoides, Esper

Campoplex pugillator, Linn. I. 5 : 79.
Apanteles abjectus, Marsh. B. 1 : 473.

Notodonta dromedarius, Linn.

Cratichneumon fabricator, Fab. I. 1 : 61.
Agrypon flaveolatum, Grav. I. 5 : 256.
Mesochorus tetricus, Hlmgr. I. 5 : 317.
Apanteles abjectus, Marsh. B. 1 : 473.
,, *octonarius,* Ratz. 1897, Ent. Mon. Mag., **33** : 257.

Notodonta ziczac, Linn.

Campoplex falcator, Fab. I. 5 : 72.
,, *pugillator,* Linn. I. 5 : 79.
Apanteles octonarius, Ratz. B. 1 : 470.

Drymonia (Notodonta) chaonia, Hb.

Phytodiaetus polyzonias, Forst. I. 3 : 242.
Campoplex falcator, Fab. I. 5 : 73.

Drymonia trimacula, Esper

Coelichneumon bilineatus, Gmel. I. 1 : 31.

Phalera bucephala, Linn.

Pimpla instigator, Fab. I. 3 : 94.
Banchus pictus, Fab. I. 3 : 284.
Campoplex carinifrons, Hlmgr. I. 5 : 70.
,, *falcator,* Fab. I. 5 : 72.
,, *oxyacanthae,* Boield I. 5 : 74.
Schizoloma amicta, Fab. I. 5 : 227.
Apanteles fulvipes, Hal. B. 1 : 486.
Meteorus fragilis, Wsm. I. 2 : 128.
Trichogramma vitripennis, Wlk. Byfleet, bred by K. G. Blair.

Pygaera curtula, Linn.

Pimpla rufipleura, Bignl. I. 3 : 62.
Labrorhychus tenuicornis, Grav. I. 5 : 249.
Paniscus testaceus, Grav. I. 5 : 296.

Pygaera anachoreta, Fab.

Megaplectes monticola, Grav. I. 2 : 324.
Paniscus testaceus, Grav. I. 5 : 296.

Pygaera pigra, Hufn. (**reclusa,** Fab.)

Cratichneumon nigritarius, Grav. I. 1 : 58.
Pimpla graminellae, Hlmgr. I. 3 : 60.
Phytodiaetus coryphaeus, Grav. I. 3 : 244.
Petalodes unicolor, Wsm. B. 1 : 266.
Tetrastichus sp. Blean Woods, bred by E. A. Cockayne.

THYATIRIDAE.

Habrosyne (Thyatira) derasa, Linn.

Campoplex pugillator, Linn. I. 5 : 79.

Thyatira batis, Linn.

Automalus alboguttatus, Grav. I. 1 : 13.
Agrypon flaveolatum, Grav. I. 5 : 255.

Palimpsestis (Cymatophora) ocularis, Linn. (**octogesima,** Hb.)

Hemiteles oxyphimus, Grav. I. 2 : 161.
Pimpla instigator, Fab. I. 3 : 94 & 95.
,, *examinator,* Fab. I. 3 : 100.

Palimpsestis or, Fab.

Cratichneumon fabricator, Fab. I. 1 : 61.
Hemiteles fulvipes, Grav. I. 2 : 124.
Labrorhychus tenuicornis, Grav. I. 5 : 249.
? *Apanteles rubripes,* Hal. B. 1 : 419.

Palimpsestis duplaris, Linn.

Apanteles sp. New Forest, bred by K. G. Blair.

Polyploca (Asphalia) flavicornis, Linn.

Pimpla brassicariae, Poda I. 3 : 110. *cf.* 117.
Ophion luteus, Linn. I. 5 : 267 & 268.

Polyploca ridens, Fab.

Campoplex pugillator, Linn. I. 5 : 79.
Ophion luteus, Linn. I. 5 : 267.
Mesochorus politus, Grav. I. 5 : 316.

NOCTUIDAE.

Metachrostis (Bryophila) muralis, Forst. (**glandifera,** Hb.)

Coelichneumon bilineatus, Gmel. I. 1 : 31.

Coelichneumon consimilis, Wsm. I. 1: 31.
,, *lineator*, Fab. I. 1 : 33.
Stenichneumon trilineatus, Gmel. I. 1 : 45.

Metachrostis perla, Fab.

Agrypon flaveolatum, Grav. I. 5 : 256.

Diphthera (Moma) alpium, Osb. (**orion**, Esper)

Pimpla instigator, Fab. I. 3 : 94.

Colocasia (Demas) coryli, Linn.

Anomalon ruficorne, Grav. I. 5 : 244.
,, *bellicosum*, Wsm. I. 5 : 246.
? *Schizoloma amicta*, Fab. I. 5 : 227.
Ophion luteus, Linn. I. 5 : 268.
Macrocentrus abdominalis, Fab. B. 2 : 236.
Meteorus pulchricornis, Wesm. B. 2 : 108. Chalfont, bred by K. G. Blair.
Microgaster sp. Horsley, bred by C. N. Hawkins.

Acronicta tridens, Schiff.

Paniscus cephalotes, Hlmgr. I. 5 : 303.
,, *testaceus*, Grav. I. 5 : 296. W. Wycombe, bred by K. G. Blair.
Sphaeropyx irrorator, Fab. B. 1 : 385.
Apanteles fulvipes, Hal. B. 1 : 486.
Microgaster connexus, Nees. B. 1 : 525.

Acronicta psi, Linn.

Ichneumon cessator, Müll. I. 1 : 155.
Hemiteles conformis, Gmel. I. 2 : 129.
,, *cingulator*, Grav. I. 2 : 135.
Panargyrops pellucidator, Grav. New Forest, bred by K. G. Blair.
Metopius micratorius, Fab. I. 4 : 6.
Phobocampa crassiuscula. Grav. I. 5 : 136.
,, *unicincta*, Grav. I. 5 : 137.
Paniscus testaceus, Grav. I. 5 : 295–6.
,, *fuscicornis*, Hlmgr. I. 5 : 299.
,, *cephalotes*, Hlmgr. I. 5 : 303.
Limnerium annulator, Zett. Hendon, bred by K. G. Blair.
Sphaeropyx irrorator, Fab. B. 1 : 385. *cf.* 47.
Apanteles ultor, Reinh. B. 1 : 445.
? *Microplitis ocellatae*, Bch. B. 1 : 499.

Acronicta leporina, Linn.

Ophion luteus, Linn. I. 5 : 268.
,, *obscurus*, Fab. I. 5 : 275.
Paniscus testaceus, Grav. I. 5 : 296.

Acronicta aceris, Linn.

Ophion luteus, Linn. I. 5 : 268.

Acronicta megacephala, Fab.

Coelichneumon leucocerus, Grav. I. 1 : 28.
Paniscus testaceus, Grav. I. 5 : 296.
,, *cephalotes*, Hlmgr. I. 5 : 303.
Apanteles sp. Enfield, bred by T. R. Eagles.

Acronicta alni, Linn.

Phobocampa crassiuscula, Grav. I. 5 : 136.
,, *unicincta*, Grav. I. 5 : 137.
Microplitis spinolae, Nees. B. 3 : 181.

Acronicta ligustri, Linn.

Phobocampa unicincta, Grav. I. 5 : 137.
Mesochorus pallidus, Brisch. I. 5 : 330.

Chamaepora (Acronicta) rumicis, Linn.

Mesostenus ligator, Grav. I. 2 : 260.
Apanteles congestus, Nees. B. 1 : 413.
Microgaster rugulosus, Nees. B. 1 : 531
,, *subcompletus*, Nees. B. 1 : 537.

Chamaepora menyanthidis, View.

Pimpla instigator, Fab. I. 3 : 94.
Erigorgus perspicillator, Grav. I. 5 : 236.

Chamaepora euphorbiae, Fab. (**myricae**, Guén.)

Coelichneumon fuscipes, Gmel. I. 1 : 26.
Ichneumon xanthorius, Forst. I. 1 : 114.
Cryptus moschator, Fab. I. 2 : 305.
Pimpla instigator, Fab. I. 3 : 95.
Exochilum brevicorne, Grav. I. 5 : 231.
Rhogas rugulosus, Nees. B. 1 : 274.
Apanteles difficilis, Nees. I. 1 : 434.

Diloba caeruleocephala, Linn.

Ichneumon sarcitorius, Linn. I. 1 : 116.
Hemiteles fulvipes, Grav. I. 2 : 124.
,, *submarginatus*, Bdg. I. 2 : 126.
,, *conformis*, Gmel. I. 2 : 129.
Cryptus cyanator, Grav. I. 2 : 304.
Pimpla instigator, Fab. I. 3 : 93.
Erigorgus fibulator, Grav. I. 5 : 238.
Anomalon latro, Schr. I. 5 : 241.
,, *cerinops*, Grav. I. 5 : 242.
Agrypon tenuitarsum, Grav. I. 5 : 251.

Mesochorus brevipetiolatus, Ratz. I. 5 : 331.
Stictopisthus formosus, Brdg. I. 5 : 338.
Apanteles ruficrus, Hal. B. 1 : 411.
,, *difficilis*, Nees. B. 1 : 434.
,, *vitripennis*, Hal. B. 3 : 179.

Arsilonche albovenosa, Goeze (**venosa**, Bork.)

Hepiopelmus leucostigmus, Grav. I. 1 : 209.
Gambrus tricolor, Grav. I. 2 : 284.
,, *ornatus*, Grav. I. 2 : 285.
Exetastes nigripes, Grav. I. 3 : 298.
Metopius dissectorius, Panz. I. 4 : 8.
Campoplex falcator, Fab. I. 5 : 72.
Erigorgus perspicillator, Grav. I. 5 : 236.
Henicospilus merdarius, Grav. I. 5 : 282.
Mesoleptus testaceus, Fab. I. 4 : 225.
Microplitis sordipes, Nees. B. 3 : 182.

Sideridis (Leucania) vitellina, Hb.

Spilichneumon gravenhorsti, Wsm. I. 1 : 183.

Sideridis obsoleta, Hb.

Aritranis carnifex, Grav. I. 2 : 293.
Echthrus armatus, Brisch. I. 2 : 326.
Pimpla melanocephala, Grav. I. 3 : 69.
Paniscus fuscicornis, Hlmgr. I. 5 : 298.
Zele testaceator, Curtis B. 2 : 244.

Sideridis straminea, Tr.

Ophion obscurus, Fab. I. 5 : 275.

Sideridis pallens, Linn.

Apanteles ruficrus, Hal. B. 1 : 411.

Hyperiodes (Leucania) turca, Linn.

Colpotrochia elegantula, Schr. I. 4 : 14.

Hyphilare (Leucania) lithargyria, Linn.

Ctenichneumon fossorius, Grav. I. 1 : 175.
Meloboris crassicornis, Grav. I. 5 : 172.
Ophion luteus, Linn. I. 5 : 268.

Hyphilare littoralis, Curtis

Apanteles ruficrus, Hal. B. 1 : 410.
,, *spurius*, Wsm. B. 1 : 426.

Arenostola (Calamia) phragmitidis, Hb.

Melanichneumon saturatorius, Linn. I. 1 : 79.

Arenostola (Tapinostola) elymi, Tr.

Exephanes hilaris, Grav. I. 1 : 159.
Limerodes arctiventris, Boield I. 1 : 166.
Lissonota cylindrator, Vill. I. 3 : 205.
Chelonus inanitus, Linn. B. 1 : 330.

Meliana flammea, Curt.

Melanichneumon saturatorius, Linn. I. 1 : 79.

Nonagria (Senta) maritima, Tausch. (**ulvae**, Hb.)

Aritranis carnifex, Grav. I. 2 : 293.

Archanara (Nonagria) algae, Esper (**cannae**, Och.)

Melanichneumon saturatorius, Linn. I. 1 : 79.
Ichneumon quaesitorius, Linn. I. 1 : 147.
Chasmias paludicola, Wsm. I. 1 : 164.

Archanara sparganii, Esper

Melanichneumon monostagon, Grav. I. 1 : 80.
Ichneumon gracilentus, Wsm. I. 1 : 138.
,, *confusorius*, Grav. I. 1 : 139.
Exephanes occupator, Grav. I. 1 : 160.
Ctenichneumon castigator, Fab. I. 1 : 172.
,, *divisorius*, Grav. I. 1 : 179.

Archanara geminipuncta, Hatch.

Coelichneumon lineator, Fab. I. 1 : 33.
Melanichneumon monastagon, Grav. I. 1 : 80.
Ichneumon quaesitorius, Linn. I. 1 : 147.
Chasmias motatorius, Fab. I. 1 : 163.
Centeterus confector, Grav. I. 1 : 281.
Aritranis carnifex, Grav. I. 2 : 293.
Paniscus testaceus, Grav. I. 5 : 296.

Phragmitiphila typhae, Esper (**arundinis**, Fab.)

Melanichneumon saturatorius, Linn. I. 1 : 79.
Ichneumon quaesitorius, Linn. I. 1 : 147.
Exephanes occupator, Grav. I. 1 : 160.
Chasmias paludicola, Wsm. I. 1 : 164.
? *Cryptus viduatorius*, Fab. I. 2 : 308.
Meloboris crassicornis, Grav. I. 5 : 172.

Xanthoecia (Gortyna) flavago, Schiff. (**ochracea,** Hb.)

Coelichneumon lineator, Fab. I. 1 : 33.
,, *impressor,* Zett. I. 1 : 37.
Ichneumon confusorius, Grav. I. 1 : 139.
Ctenichneumon castigator, Fab. I. 1 : 172.
Spilichneumon occisorius, Fab. I. 1 : 183.
,, *gravenhorsti,* Wsm. I. 1 : 183.
Procinetus decimator, Grav. I. 3 : 254.
Macrocentrus collaris, Spin. B. 2 : 239.
Hemiptarsenus unguicellus, Zett. Bred by K. G. Blair.

Apamea (Hydraecia) nictitans, Linn.

Lissonota variabilis, Hlmgr. I. 3 : 213.
Microplitis tristis, Nees. B. 3 : 182.

Hydraecia petasitis, Dbl.

Macrocentrus abdominalis, Fab. B. 2 : 236.
,, *infirmis,* Nees. B. 2 : 238.

Rhyacia (Axylia) putris, Linn.

Cratichneumon fabricator, Fab. I. 1 : 61.
Chalcid sp. Chelsea, bred by W. D. Lang.

Rhyacia (Agrotis) vestigialis, Rott.

Cryptus sponsor, Fab. I. 2 : 309.
Meteorus rubens, Nees. B. 2 : 124.

Rhyacia ripae, Hb.

Anomalon cerinops, Grav. I. 5 : 242.
,, *xanthopus,* Grav. I. 5 : 245.

Rhyacia porphyrea, Hb. (**strigula,** Thnb.)

Banchus volutatorius, Linn. I. 3 : 285.
Anilasta ruficincta, Grav. I. 5 : 211.
Phobocampa bicingulata, Grav. I. 5 : 137.
Omorga ensator, Grav. I. 5 : 154.
Ophion longicornis, Brauns I. 5 : 273.
,, *obscurus,* Fab. I. 5 : 275.
Meteorus pulchricornis, Wsm. B. 2 : 108.
Apanteles insidens, Ratz. Fernhurst, bred by K. G. Blair.

Rhyacia praecox, Linn.

Ophion luteus, Linn. I. 5 : 268.
,, *distans,* Thoms. I. 5 : 270.
Henicospilus ramidulus, Linn. I. 5 : 282.
Apanteles ruficrus, Hal. B. 1 : 411.
,, *spurius,* Wsm. B. 1 : 426.
,, *difficilis,* Nees. B. 1 : 434.

Rhyacia lucerna, Linn.

Ichneumon terminatorius, Grav. I. 1 : 130.
Amblyteles palliatorius, Grav. I. 1 : 188.

Rhyacia ashworthi, Dbl.

Amblyteles armatorius, Forst. I. 1 : 301.
Diadromus subtilicornis, Grav. I. 1 : 265.

Rhyacia (Triphaena) orbona, Hufn.

Ctenichneumon haereticus, Wsm. I. 1 : 179.
Amblyteles quadripunctorius, Müll. I. 1 : 192–193.
,, *armatorius,* Forst. I. 1 : 201.
Apanteles callidus, Hal. B. 1 : 485.
,, *fulvipes,* Hal. B. 1 : 486.

Rhyacia pronuba, Linn.

Protichneumon fusorius, Linn. I. 1 : 17.
Ichneumon extensorius, Linn. I. 1 : 136.
,, *confusorius,* Grav. I. 1 : 139.
Amblyteles quadripunctorius, Müll. I. 1 : 193.
,, *vadatorius,* Illig. I. 1 : 195.
,, *armatorius,* Forst. I. 1 : 201.
Paniscus cristatus, Thoms. I. 5 : 293.
Apanteles congestus, Nees. B. 1 : 413.
Meteorus versicolor, Wsm. B. 2 : 117.

Rhyacia (Noctua) plecta, Linn.

Cryptus obscurus, Grav. I. 2 : 311.
Pimpla examinator, Fab. I. 3 : 100.

Rhyacia ditrapezium, Linn.

Clinocentrus excubitor, Hal. B. 1 : 263.
Macrocentrus abdominalis, Fab. B. 2 : 236.

Rhyacia triangulum, Hufn.

Anilasta brischkei, Brdg. I. 5 : 216.
Stictopisthus formosus, Brdg. I. 5 : 338.
Meteorus scutellator, Nees. B. 2 : 112.
Macrocentrus thoracicus, Nees. B. 2 : 234.

Rhyacia brunnea, Schiff.

Melanichneumon leucomelas, Gmel. I. 1 : 75.
Ichneumon deliratorius, Linn. I. 3 : 113.
,, *molitorius*, Grav. I. 1 : 125.
Amblyteles negatorius, Fab. I. 1 : 197.
,, *oratorius*, Fab. I. 1 : 202.
,, *margineguttatus*, Grav. I. 1 : 203.
Pimpla maculator, Fab. I. 3 : 105.
Phytodiaetus coryphaeus, Grav. I. 3 : 244.
Meteorus luridus, Ruthe B. 2 : 129.

Rhyacia festiva, Schiff.

Ichneumon gracilentus, Wsm. I. 1 : 138.
Amblyteles oratorius, Fab. I. 1 : 202.

Rhyacia rubi, View. (**bella**, Borkh.)

Ichneumon confusorius, Grav. I. 1 : 139.

Rhyacia baia, Fab.

Rhogas circumscriptus, Nees. B. 1 : 298.

Rhyacia castanea, Esp.

Ophion obscurus, Fab. I. 5 : 275.

Rhyacia xanthographa, Schiff.

Amblyteles armatorius, Forst. I. 1 : 201.
Ophion stigmaticus, Morley I. 5 : 271.
Apanteles fulvipes, Hal. B. 1 : 486.
Meteorus scutellator, Nees. B. 2 : 112.

Triphaena fimbria, Linn.

Ichneumon gracilentus, Wsm. I. 1 : 138.
,, *primatorius*, Forst. I. 1 : 141.
Amblyteles quadripunctorius, Müll. I. 1 : 192.
,, *armatorius*, Forst. I. 1 : 200.
Pimpla instigator, Fab. I. 3 : 94.
Lissonota sulphurifera, Grav. I. 3 : 207.
Metopius micratorius, Fab. I. 4 : 7.
Ophion stigmaticus, Morley I. 5 : 271.
,, *obscurus*, Fab. I. 5 : 275.
Rhogas geniculator, Nees. B. 1 : 286.
Apanteles fulvipes, Hal. B. 1 : 486.
Microplitis tuberculifera, Wsm. B. 1 : 511.

Triphaena interjecta, Hb.

Amblyteles quadripunctorius, Müll. I. 1 : 193.

Amphipyra pyramidea, Linn.

Apanteles fulvipes, Hal. B. 1 : 486.
,, *vitripennis*, Hal. B. 3 : 179.
Melittobia acasta, Wlk. Hayward's Heath, bred by K. G. Blair.

Naenia (Mania) typica, Linn.

Melanichneumon saturatorius, Linn. I. 1 : 79.
Barichneumon lepidus, Grav. I. 1 : 102.
Amblyteles litigiosus, Wesm. I. 1 : 189.
Sagaritis femoralis, Grav. I. 5 : 96.
Microplitis sordipes, Nees. B. 3 : 182.

Parastichtis (Xylophasia) rurea, Fab.

Amblyteles armatorius, Forst. I. 1 : 200.
Rhogas nigricornis, Wsm. B. 1 : 303.

Parastichtis monoglypha, Hufn. (**polyodon**, Linn.)

Apanteles falcatus, Nees. B. 1 : 442.
Macrocentrus infirmus, Nees. B. 2 : 238.
Litomastix aestivalis, Mere. Linby, bred by J. W. Saunt.

Parastichtis (Apamea) basilinea, Fab.

Microplitis tuberculifera, Wsm. B. 1 : 511.

Parastichtis unanimis, Hb.

Ophion scutellaris, Thoms. Wicken, bred by C. N. Hawkins.
,, *parvulus*, Kr. Scilly Isles, bred by K. G. Blair.
Rhogas irregularis, Wesm. Hendon, bred by K. G. Blair.

Dipterygia scabriuscula, Linn. (**pinastri**, Linn.)

Ophion luteus, Linn. I. 5 : 268.
Henicospilus ramidulus, Linn. I. 5 : 281.

Tholera (Neuronia) popularis, Fab.

Anilasta ruficincta, Grav. I. 5 : 211.

Tholera (Luperina) cespitis, Fab.

Microplitis spinolae, Nees. B. 1 : 497.

Cerapteryx (Charaeas) graminis, Linn.

Ichneumon gradarius, Wsm. I. 1 : 135.
Ctenichneumon divisorius, Grav. Windermere, bred by K. G. Blair.

Pachetra fulminea, Fab. (**leucophaea,** View.)

Ophion obscurus, Fab. I. 5 : 275.

Luperina testacea, Hb.

Meniscus sulcator, Morley I. 3 : 234.
Ichneumon sarcitorius, Linn. Scilly Isles, bred by K. G. Blair.

Barathra (Mamestra) brassicae, Linn.

Amblyteles armatorius, Forst. I. 1 : 200.
Phygadeuon fumator, Grav. I. 2 : 99.
Pimpla brassicariae, Poda I. 3 : 110.
Exetastes cinctipes, Retz. I. 3 : 295.
,, *nigripes,* Grav. I. 3 : 298.
Ophion scutellaris, Thoms. I. 5 : 274.
Astiphrommus mandibularis, Thoms. I. 5 : 310.
Eulophus sp. Bred by K. G. Blair.

Polia (Mamestra) persicariae, Linn.

Exetastes nigripes, Grav. I. 3 : 298.

Oligia (Miana) literosa, Haw.

Limerodes arctiventris, Boield I. 1 : 166.
Lissonota sulphurifera, Grav. I. 3 : 207.
Olesicampa auctor, Grav. I. 5 : 164.
Chelonus inanitus, Linn. B. 1 : 330.

Oligia bicoloria, Vill.

Exetastes cinctipes, Retz. I. 3 : 295.

Petilampa (Miana) minima, Haw. (**arcuosa,** Haw.)

Exephanes hilaris, Grav. I. 1 : 159.
Chasmias motatorius, Fab. I. 1 : 163.
Limerodes arctiventris, Boield I. 1 : 166.

Athetis (Caradrina) morpheus, Hufn.

Campoplex terebrator, Fst. I. 5 : 75.

Athetis alsines, Brahm.

Exetastes guttatorius, Grav. I. 3 : 300.
Rhogas dimidiatus, Spin. B. 1 : 283.
,, *circumscriptus,* Nees. B. 1 : 298.
Meteorus deceptor, Wsm. B. 2 : 69.

Athetis clavipalpis, Scop. (**quadripunctata,** Fab.)

Ctenichneumon mesocastanus, Grav. I. 1 : 177.

Euxoa (Agrotis) exclamationis, Linn.

Ctenichneumon panzeri, Wsm. I. 1 : 173.

Euxoa segetum, Schiff.

Ctenichneumon panzeri, Wsm. I. 1 : 173.
Amblyteles vadatorius, Illig. I. 1 : 195.
,, *armatorius,* Forst. I. 1 : 201.
Anomalon cerinops, Grav. I. 5 : 242.
Bracon kollari, Rond. B. 1 : 171.
Microplitis seuratii, Marsh. B. 3 : 294.

Euxoa corticea, Schiff.

Amblyteles infractorius, Panz. I. 1 : 201.

Euxoa nigricans, Linn.

Cratichneumon coruscator, Linn. I. 1 : 66.
Meteorus scutellator, Nees. B. 2 : 112.

Euxoa tritici, Linn.

Amblyteles infractorius, Panz. I. 1 : 201.
Ophion obscurus, Fab. I. 5 : 275.
Ecphoropsis viennensis, Grav. I. 5 : 142.
Meteorus rubens, Nees. B. 2 : 124.
Rhogas dimidiatus, Spin. B. 3 : 139.

Eueretagrotis (Agrotis) agathina, Dup.

Sagaritis maculipes, Tschek. I. 5 : 100.
Anilasta ruficincta, Grav. I. 5 : 211.
? *Ophion stigmaticus,* Morley I. 5 : 271.
Rhogas circumscriptus, Nees. B. 1 : 298.
Meteorus pulchricornis, Wsm. B. 2 : 108.

Panolis flammea, Hb. (**piniperda,** Panz.)

Coelichneumon comitator, Linn. I. 1 : 29.
Stenichneumon trilineatus, Gmel. I. 1 : 45.
,, *scutellator,* Grav. I. 1 : 45.
Cratichneumon nigritarius, Grav. I. 1 : 58.
,, *fabricator,* Fab. I. 1 : 61.
,, *annulator,* Fab. I. 1 : 63.
,, *pallidifrons,* Grav. I. 1 : 63.
Melanichneumon dumeticola, Grav. I. 1 : 76.
Barichneumon derogator, Wsm. I. 1 : 98.
,, *bilunulatus,* Grav. I. 1 : 99.
Ichneumon molitorius, Grav. I. 1 : 125.
,, *gradarius,* Wsm. I. 1 : 135.
Amblyteles equitatorius, Panz. I. 1 : 191.
Eurylabus tristis, Grav. I. 1 : 218.
Platylabus nigrocyaneus, Grav. I. 1 : 222.
Microcryptus perspicillator, Grav. I. 2 : 29.
,, *arrogans,* Grav. I. 2 : 30.

Cryptus cyanator, Grav. I. 2 : 304.
,, *tarsoleucus*, Schr. I. 2 : 306.
,, *sponsor*, Fab. I. 2 : 309.
,, *dianae*, Grav. I. 2 : 313.
Pimpla instigator, Fab. I. 3 : 93.
Banchus variegator, Fab. I. 3 : 283.
,, *pictus*, Fab. I. 3 : 284.
,, *moniliatus*, Grav. I. 3 : 287.
Euceros crassicornis, Grav. I. 4 : 281.
Campoplex rugulosus, Fst. I. 5 : 71.
Heteropelma calcator, Wsm. I. 5 : 232.
Erigorgus carinatus, Brisch. I. 5 : 237.
Anomalon ruficorne, Grav. I. 5 : 244.
,, *biguttatum*, Grav. I. 5 : 244.
,, *xanthopus*, Grav. I. 5 : 245.
Labrorhychus nigricornis, Wsm. I. 5 : 247.
Meteorus unicolor, Htg. B. 2 : 132.

Monima (Taeniocampa) gothica, Linn.

Coelichneumon derasus, Wsm. I. 1 : 30.
Cratichneumon fugitivus, Grav. I. 1 : 65.
Cryptus obscurus, Grav. I. 2 : 311.
Agrypon aequatum, Grav. I. 5 : 258.
Ophion undulatus, Grav. I. 5 : 279.

Monima incerta, Hufn. (**instabilis,** Fab.)

Cratichneumon fugitivus, Grav. I. 1 : 65.
Ctenichneumon castigator, Fab. I. 1 : 172.
Spudastica kriechbaumeri, Bdg. I. 5 : 139–40.
Agrypon anxium, Wsm. I. 5 : 257.
Ophion luteus, Linn. I. 5 : 268.
Apanteles congestus, Nees. B. 1 : 413.
Microplitis vidua, Ruthe B. 1 : 500.
Rhogas nigricornis, Wesm. Isle of Man, bred by K. G. Blair.

Monima populi, Ström. (**populeti,** Fab.)

Cratichneumon fabricator, Fab. I. 1 : 61.
Cryptus obscurus, Grav. I. 2 : 311.
Meniscus plantarius, Grav. I. 3 : 239.
Campoplex pugillator, Linn. I. 5 : 79.
,, *confusus*, Fst. I. 5 : 82.
Anilasta carbonaria, Ratz. I. 5 : 211.
Ophion luteus, Linn. I. 5 : 268.

Monima stabilis, View.

Ichneumon latrator, Fab. I. 1 : 120.
Probolus alticola, Grav. I. 1 : 212.
Spudastica kriechbaumeri, Bdg. I. 5 : 139–140.
Angitia interrupta, Hlmgr. I. 5 : 202.
Astiphrommus strenuus, Hlmgr. I. 5 : 311.
Apanteles solitarius, Ratz. B. 1 : 406.
,, *formosus*, Wsm. B. 1 : 482.
Microplitis mediana, Ruthe B. 1 : 510.
,, *mediator*, Hal. B. 3 : 182.
Meteorus pulchricornis, Wsm. B. 2 : 108.
,, *scutellator*, Nees. B. 2 : 112.
,, *fragilis*, Wsm. B. 2 : 128.
Eulophus sp. Brentwood, bred by E. A. Cockayne.

Monima gracilis, Fab.

Meniscus murinus, Grav. I. 3 : 238.
Spudastica kriechbaumeri, Bdg. I. 5 : 140 *bis*.
Meloborus crassicornis, Grav. I. 5 : 172.
Anomalon cerinops, Grav. I. 5 : 242.
Apanteles ruficrus, Hal. Wanborough, bred by E. A. Cockayne.

Monima miniosa, Fab.

Cratichneumon nigritarius, Grav. I. 1 : 58.
,, *coruscator*, Linn. I. 1 : 66.
Glypta genalis, Möll. I. 3 : 150.
Meniscus murinus, Grav. I. 3 : 238.
Agrypon flaveolatum, Grav. I. 5 : 256.
Apanteles solitarius Ratz. B. 1 : 406.
Microplitis tuberculifera, Wsm. B. 1 : 511.
,, *fumipennis*, Ratz. B. 3 : 181.
Meteorus albiditarsus, Curtis. New Forest, bred by K. G. Blair.

Monima munda, Esper

Ophion luteus, Linn. I. 5 : 268.

Monima pulverulenta, Esper (**cruda,** Tr.)

Ctenichneumon melanocastanus, Grav. I. 1 : 176.
Cryptus obscurus, Grav. I. 2 : 311.
? *Ophion minutus*, Kriech. I. 5 : 276.

Sidemia (Orthosia) fissipuncta, Haw. (**ypsilon,** Schiff.)

Coelichneumon liocnemis, Thoms. I. 1 : 36.
,, *ferreus* var. *serina*, Grav. Loughton, bred by G. Charteris.

Amathis (Orthosia) lota, Linn.

Ophion scutellaris, Thoms. I. 5 : 274.
Meteorus unicolor, Wsm. B. 2 : 113.

Conistra (Cerastis) vaccinii, Linn.

Microplitis tuberculifera, Wsm. B. 1 : 511.

Conistra ligula, Esper **(spadicea,** Hb.)

Microplitis mediator, Hal. B. 1 : 509.

Eupsilia (Scopelosoma) satellitia, Linn.

Omorga difformis, Gmel. I. 5 : 148.
Ophion marginatus, Jur. I. 5 : 277.
Microplitis sordipes, Nees. B. 1 : 507.
Meteorus scutellator, Nees. B. 2 : 112.

Xantholeuca (Oporina) croceago, Fab.

Microplitis mediator, Hal. B. 1 : 509.

Cosmia (Xanthia) citrago, Linn.

Campoplex myrtillus, Desv. I. 5 : 77.

Cosmia fulvago, Linn.

Amblyteles castanopygus, Steph. I. 1 : 204.

Ipimorpha (Tethea) retusa, Linn.

Apanteles sericeus, Nees. B. 1 : 424.
,, *nothus,* Reinh. B. 1 : 437.
Meteorus unicolor, Wsm. B. 2 : 113.

Ipimorpha subtusa, Fab.

Apanteles placidus, Hal. Uxbridge, bred by K. G. Blair.

Dicycla oo, Linn.

Spudastica kriechbaumeri, Bdg. I. 5 : 140.

Calymnia trapezina, Linn.

Coelichneumon ruficauda, Wsm. I. 1 : 34.
Phobocampa bicingulata, Grav. I. 5 : 137.
Ophion scutellaris, Thoms. I. 5 : 274.
Paniscus virgatus, Fourc. I. 5 : 292.
Meteorus ruficeps, Nees. B. 2 : 87.
,, *scutellator,* Nees. B. 2 : 112.
Macrocentrus abdominalis, Fab. B. 2 : 236.

Calymnia diffinis, Linn.

Aethecerus nitidus, Wsm. I. 1 : 272.
Pimpla turionellae, Linn. I. 3 : 103.
? ,, *graminellae,* Hlmgr. I. 3 : 60.

Epia (Dianthoecia) irregularis, Hufn. **(echii,** Bork.)

Ichneumon xanthorius, Forst. I. 1 : 114.
Anilasta ruficincta, Grav. I. 5 : 211 *bis.*
Ophion distans, Thoms. I. 5 : 269.
Henicospilus merdarius, Grav. I. 5 : 282.
**Apanteles sericeus,* Nees. B. 3 : 177.

Harmodia (Dianthaecia) lepida, Esper **(carpophaga,** Bkh.)

Ctenichneumon castigator, Fab. I. 1 : 172.
Eurylabus tristis, Grav. I. 1 : 218.
Platylabus pumilio, Holmgr. I. 1 : 225.

Harmodia bicruris, Hufn. **(capsincola,** Esper)

Eurylabus tristis, Grav. I. 1 : 218.
Hemiteles sp. I. 2 : 117.
Cryptus obscurus, Grav. I. 2 : 311.
Labrorhychus tenuicornis, Grav. I. 5 : 249.
Ophion luteus, Linn. I. 5 : 268.
,, *scutellaris,* Thoms. I. 5 : 274.
Henicospilus ramidulus, Linn. I. 5 : 281.
Apanteles sericeus, Nees. B. 1 : 424.
Microplitis spectabilis, Hal. B. 1 : 503.
,, *tristis,* Nees. B. 1 : 504.

Harmodia rivularis, Fab. **(cucubali,** Esper)

Ctenichneumon melanocastanus, Grav. I. 1 : 176.
Hemiteles laevigatus, Ratz. I. 2 : 153.
Pimpla brevicornis, Grav. I. 3 : 75.
Anilasta ruficincta, Grav. I. 5 : 211.
Ophion luteus, Linn. I. 5 : 268.
Rhogas cruentus, Nees. B. 1 : 279.
Apanteles sericeus, Nees. B. 1 : 424.
,, *juniperatae,* Bch. B. 3 : 178.
Microplitis tristis, Nees. B. 1 : 504.

Harmodia albimacula, Bkh.

Henicospilus merdarius, Grav. I. 5 : 282.

* This is doubtless the species referred to by Wratislaw (1870, *Proc. Suff. Inst. Archaeol.,* **4:** 220) : " nearly half the caterpillars were unprofitable owing to the attacks of a small ichneumon which appears to assail them in an early stage of their growth." C. M.

Microplitis spectabilis, Hal. Kent, bred by E. A. Cockayne.

Polia (Hecatera) spinaciae, View. (**dysodea**, Schiff.)

Campoplex pugillator, Linn. I. 5 : 79.
Ophion luteus, Linn. I. 5 : 268.
Henicospilus merdarius, Grav. I. 5 : 282.
? *Glypta lugubrina*, Hlmgr. I. 3 : 164.

Polia serena, Schiff.

Sagaritis zonata, Grav. I. 5 : 100.
Angitia majalis, Grav. I. 5 : 191.
Anilasta ruficincta, Grav. I. 5 : 211.
Henicospilus merdarius, Grav. I. 5 : 282.

Polia (Hadena) glauca, Hb.

Ophion luteus, Linn. I. 5 : 268.

Polia nana, Hufn. (**dentina**, Schiff.)

Paniscus testaceus, Grav. I. 5 : 296.

Polia oleracea, Linn.

Ichneumon deliratorius, Linn. I. 1 : 113.
Ctenichneumon castigator, Fab. I. 1 : 172.
Hemiteles fulvipes, Grav. I. 2 : 124.
Exetastes cinctipes, Retz. I. 3 : 295.
,, *nigripes*, Grav. I. 3 : 298.
Pimpla instigator, Fab. I. 3 : 94.
Angitia apostata, Grav. I. 5 : 188.
Schizoloma amicta, Fab. I. 5 : 227.
Astiphromma mandibularis, Thoms. I. 5 : 310.
Ophion luteus, Linn. I. 5 : 268.
Apanteles ruficrus, Hal. B. 1 : 411.
,, *spurius*, Wsm. B. 1 : 426.
Microplitis tuberculifera, Wesm. B. 1 : 511.
Microplitis spinolae, Nees. B. 1 : 497.
Rhogas circumscriptus, Nees. B. 1 : 298.
Meteorus deceptor, Wsm. B. 2 : 69.
? *Blacus humilis*, Nees. B. 2 : 197.

Polia pisi, Linn.

Protichneumon fusorius, Linn. I. 1 : 17.
,, *pisorius*, Linn. I. 1 : 18,
Exetastes nigripes, Grav. I. 3 : 298.
Ophion luteus, Linn. I. 5 : 268.
,, *scutellaris*, Thoms. I. 5 : 274.
Henicospilus ramidulus, Linn. I. 5 : 281.
Paniscus virgatus, Fourc. I. 5 : 291.
,, *cristatus*, Thoms. I. 5 : 293.
,, *testaceus*, Grav. I. 5 : 296.
Sphaeropyx irrorator, Fab. B. 1 : 385.
Apanteles congestus, Nees. B. 1 : 413.
,, *difficilis*, Nees. B. 1 : 434.

Polia thalassina, Rott.

Cryptus obscurus, Grav. I. 2 : 311.

Polia contigua, Vill.

Exetastes nigripes, Grav. I. 3 : 298.

Antitype (Polia) flavicincta, Fab.

Microplitis mediana, Ruthe B. 1 : 510.

Dasypolia templi, Thnbg.

Amblyteles castanopygus, Steph. I. 1 : 204.

Eumichtis (Epunda) lichenea, Hb.

Ophion obscurus, Fab. I. 5 : 275.

Bombycia (Cleoceris) viminalis, Fab.

Barichneumon albicinctus, Grav. I. 1 : 96.
Sagaritis incisa, Brdg. I. 5 : 101.
Angitia exareolata, Ratz. I. 5 : 203.
Agrypon anxium, Wsm. I. 5 : 257.
,, *aequatum*, Grav. I. 5 : 258.
Paniscus gracilipes, Thoms. I. 5 : 297.
Apanteles cleoceridis, Marsh. B. 1 : 427.

Meganephria (Miselia) oxyacanthae, Linn.

Protichneumon fuscipennis, Wsm. I. 1 : 20.
Campoplex oxyacanthae, Boield I. 5 : 74.
Ophion luteus, Linn. I. 5 : 268.
Apanteles difficilis, Nees. B. 1 : 434.
,, *fulvipes*, Hal. B. 1 : 486.
Microplitis spinolae, Nees. B. 1 : 497.

Agriopis aprilina, Linn.

Cratichneumon coruscator, Linn. I. 1 : 66.
Paniscus cristatus, Thoms. I. 5 : 294.
Microplitis tuberculifera, Wsm. B. 1 : 511.

Trigonophora (Phlogophora) meticulosa, Linn.

Amblyteles armatorius, Forst. I. 1 : 200.
Microplitis tuberculifera, Wsm. B. 1 : 511.

Rhizotype (Trigonophora) flammea, Esper

Banchus pictus, Fab. I. 3 : 284.

Euplexia lucipara, Linn.

Exochilum circumflexum, Linn. I. 5 : 230.

Aplecta nebulosa, Hufn.

Amblyteles oratorius, Fab. I. 1 : 202.
Schizoloma amicta, Fab. I. 5 : 228.

Aplecta tincta, Brahm

Amblyteles palliatorius, Grav. I. 1 : 188.
Apanteles difficilis, Nees. B. 1 : 434.

Crino (Hadena) adusta, Esper

Barichneumon bilunulatus, Grav. I. 1: 99.
,, *chionomus*, Wsm. I. 1: 103.
,, *callicerus*, Grav. I. 1: 104.
Ctenichneumon fossorius, Grav. I. 1: 175.
,, *divisorius*, Grav. I. 1: 179.
Probolus alticola, Grav. I. 1 : 212.

Dryobotodes (Hadena) protea, Esper

Listrodromus nycthemerus, Grav. I. 1 : 4.
Ophion obscurus, Fab. I. 5 : 275.

Scotogramma (Hadena) trifolii, Rott. **(chenopodii,** Fab.)

Pimpla instigator, Fab. I. 3 : 94.
? *Homocidus ornatus*, Grav. I. 4 : 100.

Dichonia (Xylocampa) areola, Esper

Apanteles fulvipes, Hal. B. 1 : 486.

Chloantha (Calocampa) solidaginis, Hb.

Rhogas nigricornis, Wsm. B. 1 : 303.

Xylina (Calocampa) vetusta, Hb.

Anomalon cerinops, Grav. I. 5 : 242.
Macrocentrus collaris, Spin. B. 2 : 239.

Xylina exoleta, Linn.

Anomalon cerinops, Grav. I. 5 : 242.
Apanteles congestus, Nees. B. 1 : 413.

Lithophane (Xylina) furcifera, Hufn.

Microplitis mediator, Hal. B. 1 : 509.

Lithophane ornithopus, Rott. **(rhizolitha,** Fab.)

Macrocentrus thoracicus, Nees. B. 2 : 234.
Schizoloma amicta, Fab. I. 5 : 227.
Paniscus testaceus, Grav. I. 5 : 296.
Mesochorus vitticollis, Hlmgr. I. 5 : 320.
Stictopisthus formosus, Bdg. I. 5 : 338.
Apanteles fulvipes, Hal. B. 1 : 486.
Macrocentrus thoracicus, Nees. I. 5 : 338.

Brachionycha (Asteroscopus) sphinx, Hufn. **(cassinea,** Hb.)

Euceros albitarsus, Curt. I. 4 : 284.
Stictopisthus formosus, Bdg. I. 5 : 338.
Apanteles fulvipes, Hal. B. 1 : 487.
Meteorus versicolor, Wsm. B. 2 : 117.

Cucullia verbasci, Linn.

Amblyteles palliatorius, Grav. I. 1: 187.
,, *glaucatorius*, Fab. I. 1 : 194.
Pimpla instigator, Fab. I. 3 : 95.
Anilasta notata, Grav. I. 5 : 209.
,, *ruficincta*, Grav. I. 5 : 211.
Ophion luteus, Linn. I. 5 : 268.
Paniscus testaceus, Grav. I. 5 : 295.
Mesochorus brevipetiolatus, Ratz. I. 5 : 331.
Microplitis tristis, Nees. B. 1 : 504.
,, *mediana*, Ruthe I. 1 : 510.
Microgaster subcompletus, Nees. B. 1 : 536.

Cucullia scrophulariae, Esper

Exetastes laevigator, Vill. I. 3 : 302.
Exochilum brevicorne, Grav. I. 5 : 231.
Ophion luteus, Linn. I. 5 : 268.
,, *longigena*, Thoms. I. 5 : 272.
Paniscus testaceus, Grav. I. 5 : 296.
,, *cephalotes*, Hlmgr. I. 5 : 303.
Microgaster subcompletus, Nees. B. 1 : 536.

Cucullia rivulorum, Guén. **(lychnitis,** Röber)

Anomalon xanthopus, Grav. I. 5 : 245.
Paniscus testaceus, Grav. I. 5 : 296.

Cucullia asteris, Schiff.

Paniscus testaceus Grav. I. 5 : 296.
,, *cephalotes*, Hlmgr. I. 5 : 303.
Mesochorus anomalus, Hlmgr. I. 5 : 333.
Apanteles congestus, Nees. B. 1 : 413.
Pezomachus instabilis, Först. Lewes, bred by E. A. Cockayne.

Cucullia gnaphalii, Hb.

Casinaria ischnogaster, Thoms. I. 5 : 112.

Anilasta ruficincta, Grav. I. 5 : 211.
Paniscus testaceus, Grav. I. 5 : 296.

Cucullia absinthii, Linn.

Ctenichneumon castigator, Fab. I. 1 : 172.
Ophion luteus, Linn. I. 5 : 268.

Cucullia chamomillae, Schiff.

Ctenichneumon melanocastanus, Grav. I. 1 : 176.
Ophion luteus, Linn. I. 5 : 268.
,, *longigena*, Thms. I. 5 : 272.
Henicospilus merdarius, Grav. I. 5 : 282.
Rhogas circumscriptus, Nees. B. 1 : 298. Padstow, bred by K. G. Blair.

Abrostola tripartita, Hufn.

Amblyteles uniguttatus, Grav. I. 1 : 206.
Microplitis spinolae, Nees. B. 1 : 497.

Abrostola triplasia, Linn.

Amblyteles uniguttatus, Grav. I. 1 : 206.
Probolus alticola, Grav. I. 1 : 212.

Scolioptery x (Gonoptera) libatrix, Linn.

Pimpla instigator, Fab. I. 3 : 93.
,, *brassicariae*, Poda I. 3 : 109.

Chrysoptera (Plusia) moneta, Fab.

Spilocryptus migrator, Fab. I. 2 : 277.
Microplitis tristis, Nees. B. 1 : 504.

Phytometra (Plusia) variabilis, Vill. (**illustris**, Fab.)

Microplitis tristis, Nees. B. 1 : 504.
Microgaster subcompletus, Nees. B. 3 : 184.

Phytometra orichalcea, Fab.

Sagaritis punctata, Brdg. I. 5 : 98.

Phytometra chrysitis, Linn.

Hemiteles fulvipes, Grav. I. 2 : 124.
Gambrus tricolor, Grav. I. 2 : 284.
Apanteles congestus, Nees. B. 1 : 413.
,, *pallidipes*, Reinh. B. 1 : 479.

Phytometra festucae, Linn.

Stenichneumon culpator, Schr. I. 1 : 43.
Cratichneumon nigritarius, Grav. I. 1 : 58.
Platylabus nigrocyaneus, Grav. I. 1 : 222.
Pimpla graminellae, Hlmgr. I. 3 : 60.
Apanteles pallidipes, Reinh. B. 1 : 479.

Phytometra iota, Linn.

Apanteles pallidipes, Reinh. B. 1 : 479.

Phytometra gamma, Linn.

Coelichneumon comitator, Linn. I. 1 : 29.
Cratichneumon nigritarius, Grav. I. 1 : 58.
Melanichneumon saturatorius, Linn. I. 1 : 79.
Ctenichneumon sputator, Linn. I. 1 : 171.
Hemiteles fulvipes, Grav. I. 2 : 124.
Pezomachus tonsus, Fst. I. 2 : 206.
,, *detritus*, Fst. I. 2 : 231.
Sagaritis femoralis, Grav. I. 5 : 95.
,, *annulata*, Grav. I. 5 : 102.
Paniscus sp. I. 5 : 288.
Mesochorus anomalus, Hlmgr. I. 5 : 333.
Rhogas testaceus, Spin. B. 1 : 296.
,, *circumscriptus*, Nees. B. 1 : 298.
Apanteles congestus, Nees. B. 1 : 413.
,, *pallidipes*, Reinh. B. 1 : 479.
Microplitis spinolae, Nees. B. 1 : 497.

Syngrapha (Plusia) interrogationis, Linn.

Meloboris crassicornis, Grav. I. 5 : 172.
Apanteles fulvipes, Hal. Braemar, bred by C. N. Hawkins.

Anarta myrtilli, Linn.

Amblyteles glaucatorius, Fab. I. 1 : 194.
Banchus monilatus, Grav. I. 3 : 287.
Campoplex falcator, Fab. I. 5 : 72.
,, *myrtillus*, Desv. I. 5 : 76.
Phobocampa bicingulata, Grav. I. 5 : 137.
Anilasta notata, Grav. I. 5 : 209.
,, *ruficincta*, Grav. I. 5 : 211 *bis*.
Heteropelma calcator, Wesm. I. 5 : 232.
Labrorhychus tenuicornis, Grav. I. 5 : 249.
Paniscus cristatus, Thoms. I. 5 : 294.
,, *fuscicornis*, Hlmgr. I. 5 : 298.
Meteorus deceptor, Wesm. B. 2 : 69.

Chloridea (Heliothis) dipsacea, Linn.

Tricholabus strigatorius, Grav. I. 1 : 215.
? *Schizopyga circulator*, Panz. I. 3 : 136.
Campoplex pugillator, Linn. I. 5 : 79.
,, *bucculentus*, Hlmgr. I. 5 : 83.
Anilasta ruficincta, Grav. I. 5 : 211.
Anomalon cerinops, Grav. I. 5 : 242.

Chloridea peltigera, Schiff.

Orthostigma pumila, Nees. Dungeness, bred by A. J. Wightman.
Aspilota insidiaterix, Marsh. Dungeness, bred by A. J. Wightman.

Pyrrhia (Chariclea) umbra, Hufn.

Campoplex pugillator, Linn. I. 5 : 79.
,, *bucculentus,* Hlmgr. I. 5 : 83 *bis.*

Lithacodia (Erastria) fasciana, Linn.

Meteorus deceptor, Wesm. B. 2 : 69.

Porphyrinia noctualis, Hb. (**paula,** Hb.)

Syzeuctus irrisorius, Rossi I. 3 : 251.

Gonospileia (Euclidia) mi, Clerck

Ichneumon gracilentus, Wesm. Lewes, bred by K. G. Blair.

Catocala nupta, Linn.

Henicospilus combustus, Grav. I. 5 : 283.
Campoplex falcator, Fab. I. 5 : 308.
Astiphrommus alarius, Grav. I. 5 : 308.
? *Pimpla instigator,* Fab. I. 3 : 95.
Apanteles fulvipes, Hal. B. 1 : 487.
,, *vitripennis,* Hal. Highgate, bred by K. G. Blair.

Catocala promissa, Esper

Paniscus virgatus, Fourc. I. 5 : 292.

Ophiusa (Toxocampa) pastinum, Tr.

Exetastes guttatorius, Grav. I. 3 : 300.

Ophiusa craccae, Fab.

Coelichneumon castaneiventris, Grav. I. 1 : 39.
Phytodiaetus polyzonias, Forst. I. 3 : 242.
Paniscus testaceus, Grav. I. 5 : 296.
Apanteles fulvipes, Hal. B. 3 : 179.

Hypena rostralis, Linn.

Anilasta braccata, Gmel. I. 5 : 208.
Mesochorus crassimanus, Hlmgr. I. 5 : 328.

Hypena proboscidalis, Linn.

Casinaria ischnogaster, Thoms. I. 5 : 112.
Microgaster subcompletus, Nees. B. 1 : 536.

Bomolocha fontis, Thnb.

Agrypon variitarsum, Grav. Braunton, bred by E. Wright.

Brephos notha, Hb.

Agrypon flaveolatum, Grav. I. 5 : 256.

GEOMETRIDAE.

Ourapteryx sambucaria, Linn.

Apanteles formosus, Wesm. B. 1 : 482.

Opisthograptis luteolata, Linn.

Microgaster alvearius, Fab. B. 1 : 517.

Angerona prunaria, Linn.

Cratichneumon nigritarius, Grav. I. 1: 57.

Campaea (Metrocampa) margaritaria, Linn.

Apanteles insidens, Ratz. Epping, bred by T. R. Eagles.

Ellopia fasciaria, Linn. (**prosapiaria,** Linn.)

Phaeogenes stimulator, Grav. I. 1 : 260.
Anilasta ruficincta, Grav. I. 5 : 211.
Mesochorus sylvarum, Curtis Braemar, bred by E. A. Cockayne.
Rhogas armatus, Wesm. Braemar, bred by E. A. Cockayne.

Plagodis (Eurymene) dolabraria, Linn.

Pimpla maculator, Fab. I. 3 : 105.
Campoplex falcator, Fab. I. 5 : 72.

Phalaena (Pericallia) syringaria, Linn.

Meteorus niger, Lyle. 1913, Entomologist, **46 :** 244 & 266.
,, *pulchricornis,* Wesm. B. 2 : 108. Box Hill, bred by C. N. Hawkins.

Selenia bilunaria, Esper (**illunaria,** Hb.)

Banchus pictus, Fab. I. 3 : 284.
Apanteles juniperatae, Bch. B. 1 : 433.
,, *difficilis,* Nees. B. 1 : 435.
,, *caberae,* Marsh. B. 1 : 475.
,, *fulvipes,* Hal. B. 1 : 487.
Limneria sp. E. Aberdeen, bred by E. A. Cockayne.

Selenia lunaria, Schiff.

Cratichneumon ruficeps, Grav. I. 1 : 56.
Pimpla instigator, Fab. I. 3 : 94.
Labrorhychus tenuicornis, Gr. I. 5 : 249.

Selenia tetralunaria, Hufn.

Campoplex confusus, Fst. I. 5 : 82.

Gonodontis (Odontopera) bidentata, Clerck

Coelichneumon cyaniventris, Wesm. I. 1 : 25.
Pimpla instigator, Fab. I. 3 : 95.
Campoplex pugillator, Linn. I. 5 : 79.
,, *bucculentus,* Hlmgr. I. 5 : 83.
Phobocampa unicincta, Grav. I. 5 : 137.
Paniscus virgatus, Fourc. I. 5 : 292.
Astiphrommus plagiatus, Thoms. I. 5 : 313.
Apanteles juniperatae, Bch. B. 1 : 432.
,, *difficilis,* Nees. B. 1 : 434.
,, *insidens,* Ratz. Stow, Glos., bred by K. G. Blair.
Meteorus deceptor, Wesm. B. 2 : 69.
,, *chrysophthalmus,* Nees. B. 2 : 67.

Crocallis elinguaria, Linn.

Apanteles juniperatae, Bch. B. 1 : 433.
Meteorus deceptor, Wesm. B. 2 : 69.
Ichneumon languidus, Wesm. Braunton, bred by K. G. Blair.

Ennomos (Eugonia) autumnaria, Wernbg.

? *Pimpla ovivora,* Bh. I. 3 : 117.

Deuteronomos (Eugonia) alniaria, Linn. (**tiliaria,** Bork.)

Pimpla instigator, Fab. I. 3 : 94.
,, *rufata,* Gmel. I. 3 : 112.
? ,, *ovivora,* Bch. I. 3 : 117.
Zele discolor, Wesm. B. 2 : 246.

Colotois (Himera) pennaria, Linn.

Campoplex oxyacanthae, Boield I. 5 : 74.
,, *falcator,* Fab. Stanmore, bred by K. G. Blair.
Apanteles juniperatae, Bch. B. 1 : 433.
,, *fulvipes,* Hal. B. 1 : 487.
Meteorus deceptor, Wesm. B. 2 : 69.

Phigalia pedaria, Fab. (**pilosaria,** Schiff.)

Arenetra pilosella, Grav. I. 3 : 176.
Paniscus testaceus, Grav. I. 5 : 296.
Apanteles difficilis, Nees. B. 1 : 434.
,, *congestus,* Nees. B. 3 : 177.
,, *insidens,* Ratz. Stanmore, bred by K. G. Blair.

Biston (Amphidasys) strataria, Hufn. (**prodomaria,** Schiff.)

Campoplex falcator, Fab. I. 5 : 72.
Anilasta carbonaria, Ratz. I. 5 : 210.
Stictopisthus formosus, Bdg. I. 5 : 338.
Apanteles difficilis, Nees. B. 1 : 434.
,, *insidens,* Ratz. Epping, bred by T. R. Eagles.

Biston betularia, Linn.

Melanichneumon leucomelas, Gmel. I. 1 : 75.
Ctenichneumon castigator, Fab. I. 1 : 172.
Pimpla instigator, Fab. I. 3 : 95.
Metopius dissectorius, Panz. I. 4 : 8.
Campoplex pugillator, Linn. I. 5 : 79.
Casinaria ischnogaster, Thoms. I. 5 : 112.
Ophion mocsaryi, Brauns I. 5 : 267.
Mesochorus pallidus, Brisch. I. 5 : 330.
Apanteles difficilis, Nees. B. 1 : 434.
,, *insidens,* Ratz. Bred by K. G. Blair.
? *Aphaereta cephalotes,* Hal. B. 2 : 402.
Microgaster alvearius, Fab. Chiswick, bred by J. Waterston.

Hemerophila abruptaria, Thnbg.

Pimpla turionellae, Linn. I. 3 : 103.

Boarmia (Cleora) arenaria, Hufn. (**viduaria,** Bork.)

Coelichneumon comitator, Linn. I. 1 : 29.
Stenichneumon castigator, Fab. I. 1 : 172.
Microgaster flavipes, Hal. B. 1 : 519.

Boarmia jubata, Thnbg. (**glabraria,** Hb.)

Microgaster minutus, Reinh. B. 1 : 520.

Boarmia lichenaria, Hufn.

Labrorhychus nigricornis, Wesm. I. 5 : 247.

Boarmia repandata, Linn.

Ophion stigmaticus, Morley I. 5 : 271.
Apanteles vitripennis, Hal. B. 1 : 489.
Microgaster flavipes, Hal. B. 1 : 519.

Boarmia rhomboidaria, Schiff. (**gemmaria,** Brahm)

Apanteles triangulator, Wesm. B. 1 : 478.
,, *vitripennis,* Hal. B. 1 : 489.
Microgaster alvearius, Fab. B. 1 : 517.

Boarmia ribeata, Clerck **(abietaria,** Schiff.)

Zele discolor, Wesm. B. 2 : 246.
Meteorus deceptor, Wesm. Chalfont, bred by K. G. Blair.

Boarmia roboraria, Schiff.

Anilasta carbonaria, Ratz. I. 5 : 211.

Boarmia punctinalis, Scop. **(consortaria,** Hb.)

Pristiceros serrarius, Grav. I. 1 : 220.

Ectropis (Tephrosia) extersaria, Hb. **(luridata,** Bork.)

Cratichneumon sicarius, Grav. I. 1 : 54.
Campoplex femorator, Brdg. I. 5 : 77.

Ectropis bistortata, Goeze.

Trichomma enecator, Rossi New Forest, bred by K. G. Blair.

Gnophos obscurata, Schiff.

Campoplex pugillator, Linn. I. 5 : 79.
Anilasta notata, Grav. I. 5 : 209.
Apanteles bicolor, Nees. B. 1 : 480.

Pseudoterpna pruinata, Hufn. **(cytisaria,** Schiff.)

Canidella tristis, Grav. I. 5 : 126.
Ophion obscurus, Fab. I. 5 : 275.
Mesochorus brevipetiolatus, Ratz. I. 5 : 331.
Apanteles immunis, Hal. B. 1 : 474.
,, *triangulator,* Wsm. B. 1 : 478.
? ,, *infimus,* Hal. B. 1 : 462.

Hipparchus (Geometra) papilionaria, Linn.

Apanteles rubripes, Hal. B. 1 : 419.
Meteorus versicolor, Wesm. B. 3 : 117.

Euchloris (Phorodesma) smaragdaria, Fab.

Ichneumon quadrialbatus, Grav. I. 1 : 154.

Chlorissa (Nemoria) viridata, Linn.

Casinaria pallidipes, Brisch. I. 5 : 110.
Labrorhychus clandestinus, Grav. I. 5 : 248.

Iodis lactearia, Linn.

Mesochorus pictilis, Hlmgr. I. 5 : 334.
Apanteles caberae, Marsh. B. 1 : 475.

Hemithea aestivaria, Hb. **(strigata,** Müll. ; **thymiaria,** Schiff.)

Stenichneumon rufinus, Grav. I. 1 : 46.
Casinaria ischnogaster, Thoms. I. 5 : 112.
Phobocampa obscurella, Hlmgr. I. 5 : 138.
Labrorhychus clandestinus, Grav. I. 5 : 248.

Cosymbia (Zonosoma) punctaria, Linn.

Hypomecus quadriannulatus, Grav. I. 1 : 167.
Casinaria ischnogaster, Thoms. I. 5 : 112.
Apanteles solitarius, Ratz. B. 1 : 406.

Cosymbia linearia, Hb. **(trilinearia,** Bork.)

Hypomecus quadriannulatus, Grav. I. 1 : 167.
Apanteles solitarius, Ratz. B. 1 : 406.

Cosymbia annulata, Schulze

Campoplex sp. Marlow, bred by E. A. Cockayne.
Apanteles vitripennis, Hal. Marlow, bred by E. A. Cockayne.

Cosymbia orbicularia, Hb.

Apanteles spurius, Wesm. B. 1 : 426.

Cosymbia pendularia, Clerck

Apanteles juniperatae, Bch. Tilgate Forest, bred by T. R. Eagles.

Acidalia marginepunctata, Goeze.

Atractodes gilvipes, Hlmgr. I. 2 : 249.

Cabera pusaria, Linn.

Platylabus rufipes, Wesm. I. 1 : 223.
,, *phaleratus,* Hal. Byfleet, bred by C. N. Hawkins.
Polyblastus cothurnatus, Gr. I. 4 : 296.
Campoplex angustatus, Thoms. I. 5 : 74.
,, *foveolatus,* Fst. I. 5 : 80.
,, *leptogaster,* Hlmgr. I. 5 : 86.
Paniscus virgatus, Fourc. I. 5 : 292.
Astiphrommus plagiatus, Thoms. I. 5 : 313.
Apanteles caberae, Marsh. B. 1 : 475.

Bapta temerata, Schiff.

Campoplex pugillator, Linn. I. 5 : 79.

Semiothisa (Macaria) liturata, Clerck

Stenichneumon pictus, Grav. I. 1 : 49.
Amblyteles crispatorius, Linn. I. 1 : 190.
Cratichneumon nigritarius, Grav. I. 1 : 58.
,, *fabricator*, Fab. I. 1 : 61.
Barichneumon albicinctus, Grav. I. 1 : 96.
,, *derogator*, Wesm. I. 1 : 98.
Campoplex confusus, Fst. I. 5 : 82.

Itame (Halia) wauaria, Linn.

Apanteles spurius, Wesm. B. 3 : 178.
Pimpla maculator, Fab. Hampstead, bred by K. G. Blair.

Dyscia (Scodiona) fagaria, Thnbg. (**belgiaria,** Hb.)

Casinaria claviventris, Hlmgr. I. 5 : 111.

Bupalus piniaria, Linn.

Coelichneumon comitator, Linn. I. 1 : 29.
Cratichneumon sicarius, Grav. I. 1 : 54.
,, *nigritarius*, Grav. I. 1 : 58.
? ,, *annulator*, Fab. I. 1 : 63.
Barichneumon albicinctus, Grav. I. 1 : 96.
,, *bilunulatus*, Grav. I. 1 : 99.
Platylabus nigrocyaneus, Grav. I. 1 : 222.
,, *orbitalis*, Grav. I. 1 : 230.
Hemiteles areator, Panz. I. 2 : 133.
Polysphincta velata, Htg. I. 3 : 119.
Banchus falcator, Fab. I. 3 : 288–9.
Campoplex oxyacanthae, Boield I. 5 : 74.
,, *angustatus*, Thoms. I. 5 : 74.
Heteropelma calcator, Wesm. I. 5 : 232.
Anomalon biguttatum, Grav. I. 5 : 244.
,, *xanthopus*, Grav. I. 5 : 245.
Agrypon canaliculatum, Hlmgr. I. 5 : 254.
Mesochorus politus, Grav. I. 5 : 316.
,, *thoracicus*, Grav. I. 5 : 326.
Apanteles immunis, Hal. B. 1 : 474.

Speranza (Fidonia) limbaria, Fab. (**conspicuata,** Hb.)

Mesochorus pectoralis, Ratz., 1932, Trans. Suffolk Nat. Soc. **2** : 10.
Microplitis videca, Ruthe, 1932, Trans. Suffolk Nat. Soc. **2** : 10.

Siona (Scoria) lineata, Scop. (**dealbata,** Linn.)

Platylabus decipiens, Wesm. I. 1 : 231.

Perconia (Aspilates) strigillaria, Hb.

Hoplismenus perniciosus, Grav. I. 1 : 7.
Platylabus orbitalis, Grav. Tilford, bred by C. N. Hawkins.

Aspilates ochrearia, Rossi

Apanteles fraternus, Reinh. B. 1 : 477.

Abraxas grossulariata, Linn.

Coelichneumon comitator, Linn. I. 1 : 29.
,, *bilineatus*, Gmel. I. 1 : 31.
Stenichneumon trilineatus, Gmel. I. 1 : 45.
,, *scutellator*, Grav. I. 1 : 45.
,, *ochropis*, Gmel. I. 1 : 48.
Cratichneumon nigritarius, Grav. I. 1 : 58.
Amblyteles armatorius, Fst. Strangford, bred by G. Foster.
? *Ephialtes carbonarius*, Chr. I. 3 : 42.
Theronia atalantae, Poda I. 3 : 51.
Pimpla examinator, Fab. I. 3 : 100.
,, *alternans*, Grav. I. 3 : 106.
,, *rufata*, Gmel. I. 3 : 112.
Casinaria vidua, Grav. I. 5 : 108.
,, *orbitalis*, Grav. I. 5 : 109.
Astiphrommus sericans, Curtis I. 5 : 306.
,, *graniger*, Thoms. I. 5 : 309.
Mesochorus tetricus, Hlmgr. I. 5 : 318.
,, *fulgurans*, Curtis I. 5 : 319.
,, *pectinipes*, Brdg. I. 5 : 319.
,, *fuscicornis*, Brisch. I. 5 : 324.
Stictopisthus complanatus, Hal. I. 5 : 336.
Apanteles limbatus, Marsh. B. 1 : 417.
? ,, *rubripes*, Hal. B. 1 : 419.
,, *glomeratus*, Linn. B. 1 : 421.
,, *nothus*, Reinh. B. 1 : 437.
,, *callidus*, Hal. B. 1 : 485.
Meteorus rubriceps, Ratz. B. 2 : 109.

Ligdia adustata, Schiff.

Meteorus deceptor, Wesm. Tilgate Forest, bred by T. R. Eagles.

Lomaspilis marginata, Linn.

Campoplex bucculentus, Hlmgr. I. 5 : 83.
Phobocampa unicincta, Grav. I. 5 : 137.
Omorga difformis, Gmel. I. 5 : 148.
Holocremna clandestina, Hlmgr. I. 5 : 219.
Apanteles caberae, Marsh. B. 1 : 475.

Pachycnemia hippocastanaria, Hb.

Campoplex angustatus, Thoms. I. 5 : 74.

Theria (Hybernia) rupicapraria, Schiff.

Campoplex leptogaster, Hlmgr. I. 5 : 86.
,, *erythrogaster,* Fst. I. 5 : 87.

Erannis (Hybernia) leucophaearia, Schiff.

Apanteles immunis, Hal. B. 1 : 474.
Meteorus pulchricornis, Wesm. B. 2 : 108.

Erannis aurantiaria, Hb.

Ophion obscurus, Fab. I. 5 : 275.
,, *minutus,* Kriech. I. 5 : 276.

Erannis marginaria, Fab. **(progemmaria,** Hb.)

Hemiteles areator, Panz. I. 2 : 133.
? *Campoplex angustatus,* Thoms. I. 5 : 75.
Casinaria moesta, Grav. I. 5 : 111.
,, *ischnogaster,* Thoms. I. 5 : 112.
Phobocampa bicingulata, Grav. I. 5 : 137.
Angitia rufipes, Grav. I. 5 : 189.
Mesochorus semirufus, Hlmgr. I. 5 : 322.
Apanteles immunis, Hal. B. 1 : 474.
,, *juniperatae,* Bch. B. 3 : 178.

Erannis defoliaria, Clerck

Platylabus pedatorius, Fab. I. 1 : 224.
Microcryptus nigrocinctus, Grav. I. 2 : 42.
Casinaria moesta, Grav. I. 5 : 111.
Phobocampa crassiuscula, Grav. Stanmore, bred by K. G. Blair.
Anilasta clausa, Brisch. I. 5 : 215.
Agrypon flaveolatum, Grav. I. 5 : 255.
Paniscus virgatus, Fourc. I. 5 : 292.
Apanteles solitarius, Ratz. B. 1 : 406.
,, *salebrosus,* Marsh. B. 3 : 176.

Alsophila (Anisopteryx) aescularia, Schiff.

Sagaritis incisa, Bdg. I. 5 : 101.
Cymodusa cruentata, Grav. I. 5 : 103.
Labrorhychus tenuicornis, Grav. I. 5 : 249.
Meteorus pulchricornis, Wesm. B. 2 : 108.

Operophthera (Cheimatobia) brumata, Linn.

Campoplex pugillator, Linn. I. 5 : 79.
Sagaritis zonata, Grav. I. 5 : 100.
Phobocampa crassiuscula, Grav. I. 5 : 136.
,, *unicincta,* Grav. I. 5 : 137.
Agrypon flaveolatum, Grav. I. 5 : 256.
Paniscus virgatus, Fourc. I. 5 : 292.
Mesochorus confusus, Hlmgr. I. 5 : 323.
,, *crassimanus,* Hlmgr. I. 5 : 328.
Apanteles immunis, Hal. B. 1 : 474.
,, *juniperatae,* Bche B. 3 : 178.
Meteorus pallidus, Nees. B. 2 : 70.
,, *ictericus,* Nees. B. 2 : 80.
,, *pulchricornis,* Wesm. B. 2 : 108.

Operophthera fagata, Scharfnbg. **(boreata,** Hb.)

Paniscus virgatus, Fourc. I. 5 : 292.

Oporinia (Oporabia) dilutata, Schiff.

Pimpla turionellae, Linn. I. 3 : 103.
Sagaritis zonata, Grav. I. 5 : 100.
Paniscus virgatus, Fourc. I. 5 : 292.
Mesochorus confusus, Hlmgr. I. 5 : 323.
Apanteles salebrosus, Marsh. B. 1 : 407.
,, *immunis,* Hal. B. 1 : 474.
Meteorus pulchricornis, Wesm. B. 2 : 108.

Entephria (Larentia) caesiata, Schiff.

Cryptopimpla blanda, Grav. Braemar, bred by E. A. Cockayne.
Ichneumon labrator, Fab. Braemar, bred by E. A. Cockayne.
Meteorus deceptor, Wesm. Braemar, bred by E. A. Cockayne.

Calostigia (Larentia) pectinitaria, Knoch **(viridaria,** Fab.)

Apanteles fulvipes, Hal. B. 1 : 487.
Microgaster marginatus, Nees. B. 1 : 524.

Calostigia didymata, Linn.

Ecphoropsis fuscipes, Hlmgr. Chilworth, bred by C. N. Hawkins.

Perizoma (Emmelesia) alchemillata, Linn.

Exochus lativentris, Thoms. I. 4 : 39.
Sagaritis femoralis, Grav. I. 5 : 96.
Labrorhychus clandestinus, Grav. I. 5 : 248.
Apanteles sericeus, Nees. B. 1 : 424.
,, *juniperatae,* Bch. B. 1 : 432.

Perizoma flavofasciata, Thnbg.
(decolorata, Hb.)

Microgaster tibialis, Nees. B. 1 : 544.

Perizoma bifasciata, Haw.
(unifasciata, Haw.)

Platylabus rubellus, Gmel. I. 1 : 232.

Eupithecia venosata, Fab.

Campoplex nitidulator, Hlmgr. I. 5 : 75.
,, *obreptans,* Fst. I. 5 : 89.
Meteorus luridus, Ruthe B. 2 : 129.

Eupithecia insigniata, Hb.
(consignata, Bork.)

Paniscus tarsatus, Brisch. I. 5 : 290.

Eupithecia linariata, Fab.

Pimpla inquisitor, Scop. I. 3 : 64.
Angitia armillata, Grav. I. 5 : 197.
Schizoloma amicta, Grav. I. 5 : 227.
Labrorhychus clandestinus, Grav. I. 5 : 248.
? *Mesochorus tachypus,* Hlmgr. I. 5 : 332.
Microgaster globatus, Nees. B. 1 : 541.

Eupithecia pulchellata, Steph.

Platylabus tricingulatus, Grav. I. 1 : 231.
? *Barichneumon eupitheciae,* Brisch. I. 1 : 95.
Campoplex zonellus, Fst. I. 5 : 90.
Limnerium deficiens, Grav. I. 5 : 117.
Angitia exareolata, Ratz. I. 5 : 203.
Apanteles sericeus, Nees. B. 1 : 424.

Eupithecia centaureata, Schiff.
(oblongata, Thnbg.)

Panargyrops aereus, Grav. I. 2 : 105.
Mesochorus pectoralis, Ratz. I. 5 : 331.
Apanteles difficilis, Nees. B. 1 : 434.

Eupithecia succenturiata, Linn.

Limnerium geniculatum, Grav. I. 5 : 115.
Paniscus tarsatus, Brisch. I. 5 : 290.
,, *virgatus,* Fourc. I. 5 : 292.
Mesochorus brevipetiolatus, Ratz. I. 5 : 331.
? *Microplitis spectabilis,* Hal. B. 1 : 503.
,, *tuberculifera,* Wsm. B. 1 : 511.

Eupithecia icterata, Vill.
var. **subfulvata,** Haw.

Microplitis mediator, Hal. B. 1 : 509.

Eupithecia palustraria, Dbl.
(pygmeata, Hb.)

Omorga faunus, Grav. I. 5 : 146.

Eupithecia helveticaria, Bdv.

Cratichneumon fugitivus, Grav. I. 1 : 65.
Barichneumon tergenus, Grav. I. 1 : 90.
,, *eupitheciae,* Brisch. I. 1 : 95.
Holocremna clandestina, Hlmgr. I. 5 : 219.
Microdus cingulipes, Nees. B. 1 : 582.

Eupithecia satyrata, Hb.

Phobocampa crassiuscula, Grav. I. 5 : 136.

Eupithecia castigata, Hb.

Mesoleptus testaceus, Fab. I. 4 : 225.
Angitia rufipes, Grav. I. 5 : 188.
Labrorhychus clandestinus, Grav. I. 5 : 248.
Paniscus tarsatus, Brisch. I. 5 : 290.
,, *gracilipes,* Thoms. I. 5 : 298.
Mesochorus semirufus, Hlmgr. I. 5 : 322.
Rhogas circumscriptus, Nees. B. 1 : 298.
Microplitis tuberculifera, Wsm. B. 1 : 511.
Tyndarius scaurus, Wlk. Dunwich, bred by K. G. Blair.

Eupithecia trisignaria, H.-S.

Exochus podagricus, Grav. I. 4 : 35.
,, *pallidipes,* Hlmgr. I. 4 : 36.
Pimpla detrita, Hlmgr. I. 3 : 88.
Agrypon flaveolatum, Grav. I. 5 : 256.

Eupithecia virgaureata, Dbl.

Paniscus tarsatus, Brisch. I. 5 : 290.
Meteorus ictericus, Nees. B. 2 : 80.

Eupithecia extensaria, Frr.

Paniscus tarsatus, Brisch. I. 5 : 290.

Eupithecia pimpinellata, Hb.

Platylabus pedatorius, Fab. I. 1 : 224.
Omorga mutabilis, Hlmgr. I. 5 : 145.
Mesochorus fulgurans, Curt. I. 5 : 318.
,, *testaceus,* Grav. I. 5 : 321.

Mesochorus confusus, Hlmgr. I. 5 : 323.
,, *brevipetiolatus*, Ratz. I. 5: 331.
Rhogas tristis, Wesm. B. 1 : 287.
,, *modestus*, Reinh. B. 1 : 295.
Apanteles juniperatae, Bche. B. 1 : 432.
,, *difficilis*, Nees. B. 1 : 434.

Eupithecia valerianata, Hb.

Labrorhychus clandestinus, Grav. I. 5 : 248.
Agrypon flaveolatum, Grav. I. 5 : 256.
Apanteles sericeus, Nees. B. 1 : 424.

Eupithecia denotata, Hb. (**campanulata**, H.-S.)

Sagaritis raptor, Zett. I. 5 : 97.
,, *incisa*, Bdg. I. 5 : 101.
Microgaster globatus, Nees. B. 1 : 541.
,, *crassicornis*, Ruthe B. 1 : 542.

Eupithecia innotata, Hufn.

Platylabus pedatorius, Fab. I. 1 : 224.
Mesochorus brevipetiolatus, Ratz. I. 5 : 331.

Eupithecia indigata, Hb.

Angitia majalis, Grav. I. 5 : 191.
,, *tibialis*, Grav. I. 5 : 198.

Eupithecia nanata, Hb.

Platylabus pedatorius, Fab. I. 1 : 224.
Campoplex juvenilis, Fst. I. 5 : 85.
Apanteles juniperatae, Bch. B. 1 : 432.

Eupithecia subnotata, Hb.

Platylabus pedatorius, Fab. I. 1 : 224.

Eupithecia vulgata, Haw.

Paniscus tarsatus, Brisch. I. 5 : 290.

Eupithecia tripunctaria, H.-S. (**albipunctata**, Haw.)

Platylabus pedatorius, Fab. I. 1 : 224.
Pimpla detrita, Hlmgr. I. 3 : 88.
Labrorhychus clandestinus, Grav. I. 5 : 248.

Eupithecia expallidata, Dbl.

Campoplex disclosus, Fst. I. 5 : 90.
Casinaria morionella, Hlmgr. I. 5 : 110.
Holocremna incrassator, Hlmgr. I. 5 : 218.
Meteorus caligatus, Hal. B. 1 : 65.

Eupithecia absinthiata, Clerck

Platylabus pactor, Wesm. I. 1 : 234.
? Perithous varius, Grav. I. 3 : 48.
? Mesoleptus testaceus, Fab. I. 4 : 225.
Campoplex pugillator, Linn. I. 5 : 79.
Casinaria morionella, Hlmgr. I. 5 : 110.
Limnerium albidum, Gmel. I. 5 : 115.
Labrorhychus clandestinus, Grav. I. 5 : 248.
Paniscus tarsatus, Brisch. I. 5 : 290.
,, *virgatus*, Fourc. I. 5 : 292.
Mesochorus vittator, Hlmgr. I. 5 : 329.
,, *temporalis*, Thoms. Corton, bred by K. G. Blair.
Ascogaster quadridentatus, Wsm. B. 1 : 336.
Meteorus neesi, Ruthe B. 2 : 85.

Eupithecia goossensiata, Mab. (**minutata**, Gn.)

Platylabus pactor, Wesm. I. 1 : 234.
Mesochorus tachypus, Wesm. I. 5 : 332.

Eupithecia assimilata, Dbl.

Angitia exareolata, Ratz. I. 5 : 203.
Apanteles lateralis, Hal. B. 1 : 488.

Eupithecia tenuiata, Hb.

Pimpla maculata, Fab. Holmwood, Surrey, bred by W. Rait-Smith.

Eupithecia lariciata, Frr.

Labrorhychus clandestinus, Grav. I. 5 : 248.
Paniscus tarsatus, Brisch. I. 5 : 290.
Mesochorus tachypus, Hlmgr. I. 5 : 332.
Apanteles juniperatae, Bche. B. 1 : 432.

Eupithecia abbreviata, Steph.

Euceros crassicornis, Grav. I. 4 : 281.
Campoplex pugillator, Linn. I. 5 : 79.
Paniscus tarsatus, Brisch. I. 5 : 290.
Apanteles congestus, Nees. B. 1 : 413.

Eupithecia dodoneata, Gn.

Casinaria morionella, Hlmgr. I. 5 : 110.
Apanteles vitripennis, Hal. Ranmore, bred by K. G. Blair.

Eupithecia exiguata, Hb.

Platylabus pedatorius, Fab. I. 1 : 224.
Phobocampa crassiuscula, Grav. I. 5 : 136.
Paniscus tarsatus, Brisch. I. 5 : 290.

Apanteles juniperatae, Bche. B. 1 : 432.
,, *xanthostigmus*, Hal. B. 1 : 449.
Microplitis tuberculifera, Wsm. B. 1 : 511.
? ,, *spectabilis*, Hal. B. 1 : 503.
Meteorus scutellator, Nees. B. 2 : 112.
,, *versicolor*, Wesm. B. 2 : 117.

Eupithecia sobrinata, Hb.

Platylabus pedatorius, Fab. I. 1 : 224.
Sagaritis raptor, Zett. I. 5 : 97.
Rhogas testaceus, Spin. B. 1 : 296.
Apanteles spurius, Wesm. B. 1 : 426.
,, *juniperatae*, Bche. B. 1 : 432.
,, *difficilis*, Nees. B. 1 : 434.
Meteorus brunnipes, Ruthe B. 2 : 102.

Gymnoscelis (Eupithecia) pumilata, Hb.

Labrorhychus clandestinus Grav. I. 5 : 248.
Agrypon flaveolatum Grav. I. 5 : 256.

Chloroclystis (Eupithecia) coronata, Hb.

Labrorhychus clandestinus Grav. I. 5 : 248.
Mesochorus fuscicornis Brisch. I. 5 : 324.
? *Pimpla detrita*, Hlmgr. I. 3 : 88.

Chloroclystis rectangulata, Linn.

Barichneumon albicinctus, Grav. I. 1 : 96.
Limnerium albidum, Gmel. I. 5 : 115.
Phobocampa unicincta, Grav. I. 5 : 137.
? *Anilasta coxalis*, Brisch. I. 5 : 216.

Chloroclystis debiliata, Hb.

Angitia majalis, Grav. I. 5 : 191.

Collix sparsata, Fr.

Apanteles ruficrus, Hal. B. 1 : 411.

Mysticoptera (Lobophora) sexalata, Retz.

Platylabus orbitalis, Grav. I. 1 : 230.

Nothopteryx (Lobophora) carpinata, Bkh. (**lobulata**, Hb.)

Platylabus pedatorius, Fab. I. 1 : 224.
Microgaster calceatus, Hal. B. 1 : 521.

Thera juniperata, Linn.

Stenichneumon pictus, Grav. I. 1 : 49.
Platylabus orbitalis, Grav. I. 1 : 230.
Pimpla alternans, Grav. I. 3 : 106.
,, *maculata*, Fab. Dorking, bred by C. N. Hawkins.
Ecphoropsis viennensis, Grav. I. 5 : 142.
Angitia armillata, Grav. I. 5 : 197.
Campoplex sp. Crathie, bred by E. A. Cockayne.
Apanteles sericeus, Nees. B. 1 : 424.
,, *spurius*, Wesm. B. 1 : 426.
Meteorus cinctellus, Nees. B. 2 : 122.

Thera cognata, Thnbg. (**simulata**, Hb.)

Angitia armillata, Grav. Braemar, bred by C. N. Hawkins.
Copidosoma sp. Braemar, bred by C. N. Hawkins.

Thera variata, Schiff.

Heteropelma calcator, Wesm. I. 5 : 232.
Mesochorus crassicrus, Thoms. I. 5 : 324.
,, *thoracicus*, Grav. I. 5 : 326.
Apanteles vitripennis, Hal. B. 1 : 489.
Microgaster calceatus, Hal. B. 1 : 521.

Thera obeliscata, Hb.

Meteorus albiditarsus, Curtis Oxshott, bred by K. G. Blair.
Apanteles sp. New Forest, bred by K. G. Blair.

Thera firmata, Hb.

Platylabus pedatorius, Fab. I. 1 : 224.
Angitia armillata, Grav. Braemar, bred by C. N. Hawkins.
Copidosoma sp. Braemar, bred by C. N. Hawkins.

Hydriomena (Ypsipetes) ruberata, Frr.

Barichneumon albicinctus, Grav. I. 1 : 96.
Pimpla instigator, Grav. I. 3 : 94.
Glypta parvicaudata, Bdg. I. 3 : 162.
? *Omorga fasciata*, Bdg. I. 5 : 157.

Hydriomena coerulata, Fab. (**trifasciata**, Bork. ; **impluviata**, Hb.)

Platylabus rufus, Wesm. I. 1 : 223.
Campoplex lapponicus, Hlmgr. I. 5 : 83.
Anilasta caedator, Grav. I. 5 : 213.
Labrorhychus clandestinus, Grav. I. 5 : 248.
Agrypon flaveolatum, Grav. I. 5 : 256.

Apanteles sericeus, Nees. B. 1 : 424.
,, *spurius*, Wesm. B. 1 : 426.
,, *xanthostigmus*, Hal. B. 1 : 449.

Hydriomena furcata, Thnbg. (**elutata**, Hb.)

Coelichneumon lineator, Fab. I. 1 : 33.
Phobocampa alticollis, Thoms. I. 5 : 135.

Eulype (Melanippe) hastata, Linn.

Pimpla brevicornis, Grav. I. 3 : 75.
Campoplex lapponicus, Hlmgr. I. 5 : 83.
Apanteles sericeus, Nees. B. 1 : 424.

Xanthorhoë (Melanippe) montanata, Schiff.

Platylabus dimidiatus, Grav. I. 1 : 234.

Xanthorhoë fluctuata, Linn.

Platylabus dimidiatus, Grav. I. 1 : 234.
? *Protichneumon erythrogaster*, Steph. I. 1 : 19.
Barichneumon albicinctus, Grav. I. 1 : 96.
Platylabus orbitalis, Grav. I. 1 : 230.
Pimpla ventricosa, Tschek. I. 3 : 91.
Paniscus gracilipes, Thoms. I. 5 : 297.
Meteorus deceptor, Wesm. B. 2 : 69.
,, *abdominator*, Nees. B. 2 : 104.

Epirrhoë (Melanippe) galiata, Schiff.

Hypomecus quadriannulatus, Grav. I. 1 : 167.
Cryptopimpla errabunda, Grav. I. 3 : 182.
Phytodiaetus polyzonias, Forst. I. 3 : 242.
Mesochorus fuscicornis, Brisch. I. 5 : 324.
,, *pectoralis*, Ratz. I. 5 : 331.
Apanteles difficilis, Nees. B. 1 : 435.
,, *nothus*, Reinh. B. 1 : 437.
,, *fulvipes*, Hal. B. 1 : 487.
Microplitis mediana, Ruthe B. 1 : 510.

Euphyia (Anticlea) cuculata, Hüfn. (**sinuata**, Hb.)

Platylabus albinus, Grav. I. 1 : 228.
,, *decipiens*, Wesm. I. 1 : 231.
Cryptopimpla errabunda, Grav. I. 3 : 182.
Casinaria orbitalis, Grav. I. 5 : 109.
,, *morionella*, Hlmgr. I. 5 : 110.
Henicospilus merdarius, Grav. I. 5 : 282.

Euphyia rubidata, Schiff.

Platylabus albinus, Grav. I. 1 : 228.
Cryptopimpla errabunda, Grav. I. 3 : 182.
Campoplex pugillator, Linn. I. 5 : 79.
Rhogas circumscriptus, Nees. B. 1 : 298.

Euphyia (Camptogramma) bilineata, Linn.

Angitia cerophaga, Grav. I. 5 : 195.

Euphyia (Cidaria) picata, Hb.

Cryptus dianae, Grav. I. 2 : 313.

Euphyia corylata, Thnbg.

Cratichneumon rufifrons, Grav. I. 1 : 57.

Euphyia silaceata, Schiff.

Platylabus dolorosus, Grav. I. 1 : 227.
,, *histrio*, Wesm. Box Hill, bred by C. N. Hawkins.

Coenotephria (Anticlea) berberata, Schiff.

Hypomecus quadriannulatus, Grav. I. 1 : 167.
? *Homocidus pectoratorius*, Grav. I. 4: 93.
Euceros crassicornis, Grav. I. 4 : 281.

Coenotephria (Cidaria) sagittata, Fab.

Platylabus pumilio, Hlmgr. I. 1 : 225.
Mesochorus confusus, Hlmgr. I. 5 : 323.

Cidaria (Dysstroma) truncata, Hufn.

Meteorus deceptor, Wesm. Braemar, bred by C. N. Hawkins.

Earophila (Anticlea) badiata, Schiff.

Cryptopimpla caligata, Grav. I. 3 : 179.
,, *brachycentra*, Grav. I. 3 : 181.
Apanteles nothus, Reinh. B. 1 : 437.

Horisme (Phibalapteryx) tersata, Schiff.

Platylabus orbitalis, Grav. I. 1 : 230.

Horisme vitalbata, Schiff.

Apanteles sp. Dorking, bred by E. A. Cockayne.

Calocalpe (Eucosmia) cervinalis, Scop. (**certata**, Hb.)

Angitia exareolata, Ratz. Mickleham, bred by E. A. Cockayne.
Apanteles difficilis, Nees. B. 1 : 435.
Meteorus chrysophthalmus, Wesm. B. 2 : 67.

Calocalpe undulata, Linn.

Exetastes guttatorius, Grav. New Forest, bred by K. G. Blair.

Chloroclysta (Cidaria) siterata, Hufn.

Limnerium xanthostoma, Grav. I. 5 : 117.

Lygris (Cidaria) testata, Linn.

Platylabus orbitalis, Grav. I. 1 : 230.
Apanteles solitarius, Ratz. B. 3 : 176.
Microplitis spectabilis, Hal. B. 3 : 181.
,, *tuberculifera,* Wesm. B. 3 : 182.

Lygris pyraliata, Schiff. **(populata,** Linn.)

Anilasta carbonaria, Ratz. I. 5 : 211.
Apanteles sp. Braemar, bred by C. N. Hawkins.

Cidaria fulvata, Först.

Stenichneumon pictus, Grav. I. 1 : 49.
Angitia armillata, Grav. I. 5 : 197.
Apanteles juniperatae, Bche. B. 1 : 433.

Pelurga comitata, Linn.

Platylabus pedatorius, Fab. I. 1 : 224 & 307.
Campoplex anceps, Hlmgr. I. 5 : 81.

Larentia (Eubolia) clavaria, Haw. **(cervinata,** Schiff.)

Sagaritis zonata, Grav. I. 5 : 100.

Ortholitha (Eubolia) chenopodiata, Linn. **(limitata,** Scop.)

Limerodes arctiventris, Boield I. 1 : 166.

Lithostege griseata, Schiff.

Paniscus brachycerus, Thoms. I. 5 : 299.

Chesias legatella, Schiff. **(spartiata,** Fuess.)

Campoplex bucculentus, Hlmgr. I. 5 : 83.
Mesochorus brevipetiolatus, Ratz. I. 5 : 331.
Apanteles fulvipes, Hal. B. 1 : 487.
Meteorus deceptor, Wesm. B. 2 : 69.

PYRALIDAE.

Synaphe (Cledeobia) angustalis, Schiff.

Lissonota insignita, Grav. I. 3 : 191.

Pyralis farinalis, Linn.

Polyclistus mansuetor, Grav. I. 4 : 26–7.

Scoparia murana, Curtis

Lissonota rufomedia, Brdg. I. 3 : 214.
Meteorus punctiventris, Ruthe B. 2 : 93.

Scoparia lineola, Curtis.

Lissonota halidaii, Hlmgr. I. 3 : 212.

Scoparia crataegella, Hb.

Angitia interrupta, Hlmgr. I. 5 : 202.

Scoparia frequentella, St.

Chelonus parcicornis, H.-S.

Scoparia angustea, Steph. **(coarctata,** Zell.)

Lissonota variabilis, Hlmgr. I. 3 : 213.
,, *rufomedia,* Bdg. I. 3 : 214.
Nemeritis gracilis, Grav. I. 5 : 133.
Meteorus punctiventris, Ruthe B. 2 : 93.

Scoparia truncicolella, St. **(mercurella,** Zeller)

Exochus flavomarginatus, Hlmgr. I. 4 : 45.
Meteorus pulchricornis, Wesm. B. 2 : 108.
Anacharis eucharoides, Walk. Entomologist, **65 :** 40.

Nomophila noctuella, Schiff. **(hybridalis,** Hb.)

Meteorus dejanus, Rond. B. 2 : 133.

Pyrausta aurata, Scop.

Agathis rufipalpis, Nees. B. 3 : 191.

Pyrausta purpuralis, Linn.

Agathis brevisetis, Nees. B. 1 : 568.

Pyrausta (Scopula) alpinalis, Schiff.

Meteorus ictericus, Nees. B. 2 : 80.

Pyrausta olivalis, Schiff.

Exochus prosopius, Grav. I. 4 : 44.

Pyrausta (Botys) nubilalis, Hb.

Colpognathus celerator, Grav. I. 1 : 279.

Pyrausta asinalis, Hb.

Lissonota nitida, Bdg. I. 3 : 198.
,, *bellator,* Grav. I. 3 : 200.

Pyrausta (Ebulea) stachydalis, Zinck.

Anilasta tricincta, Hlmgr. I. 5 : 214.

Eurrhypara urticata, Linn.

Limnerium xanthostoma, Grav. Hendon, bred by K. G. Blair.
Macrocentrus limbator, Ratz. B. 2 : 240.

Notarcha (Botys) ruralis, Scop. **(verticalis,** Schiff.)

Panargyrops aereus, Grav. I. 2 : 105.
Hemiteles conformis, Gmel. I. 2 : 129.
Theronia atalantae, Poda I. 3 : 51.
Pimpla brassicariae, Poda I. 3 : 110.
Charops decipiens, Grav. I. 5 : 66.
Limnerium rufifemur, Thoms. I. 5 : 116.
Angitia majalis, Grav. I. 5 : 191.
,, *fenestralis,* Hlmgr. I. 5 : 192.
? *Apanteles pallidipes,* Reinh. B. 1 : 479.
Microgaster subcompletus, Nees, B. 1 536.
,, *globatus,* Nees. B. 1 : 541.
Macrocentrus abdominalis, Fab. B. 2 : 236.

Phlyctaenia (Botys) terrealis, Tr.

Exochus squalidus, Hlmgr. I. 4 : 41.

Phlyctaenia (Ebulea) crocealis, Hb.

Apanteles obscurus, Nees. B. 1 : 457.
Microgaster tibialis, Nees. B. 3 : 184.

Phlyctaenia sambucalis, Schiff.

Pycnocryptus peregrinator, Linn. I. 2 : 269.
Goniocryptus titillator, Linn. I. 2 : 299.
Omorga mutabilis, Hlmgr. I. 5 : 146.

Mesographe (Pionea) forficalis, Linn.

Theronia atalantae, Poda I. 3 : 51.
Limnerium geniculatum, Grav. I. 5 : 115.
Ophion minutus, Kriech. I. 5 : 276.
Apanteles spurius, Wesm. B. 1 : 426.
,, *picipes,* Bche. B. 1 : 490.

PTEROPHORIDAE.

Schreckensteinia (Chrysocoris) festatiella, Hb.

Hemiteles marginatus, Brdg. I. 2 : 125.
,, *cingulator,* Grav. I. 2 : 135.
Agrypon minutum, Brdg. I. 5 : 255.
Mesochorus vitticollis, Hlmgr. I. 5 : 320.

Platyptilia (Cnaemidophorus) rhododactyla, Fab.

Apanteles impurus, Nees. B. 3 : 179.

Platyptilia isodactyla, Zell.

Microgaster globatus, Nees. B. 1 : 541.

Platyptilia (Amblyptilia) acanthodactyla, Hb.

Exephanes occupator, Grav. I. 1 : 160.

Oxyptilus heterodactylus, Vill. **(teucrii,** Jordan)

Meloboris crassicornis, Grav. I. 5 : 172.
Anilasta ruficincta, Grav. I. 5 : 211.
,, *barretti,* Brdg. I. 5 : 212.
,, *rapax,* Grav. Dunwich, bred by K. G. Blair.
Stictopisthus complanatus, Hal. I. 5 : 336.

Marasmarcha (Mimaeseoptilus) phaeodactyla, Hb.

Ischnus thoracicus, Grav. I. 1 : 284.

Stenoptilia (Mimaesoptilus) bipunctidactyla, Haw. **(plagiodactylus,** St.)

Anilasta ruficincta, Grav. I. 5 : 211.
Apanteles sericeus, Nees. B. 1 : 424.
,, *gagates,* Nees. B. 1 : 463.

Stenoptilia pterodactyla, Linn. **(fuscus,** Retz.)

Angitia rufipes, Grav. I. 5 : 189.
,, *cylindrica,* Brisch. I. 5 : 196.

Pterophorus (Leioptilus) tephradactylus, Hb.

Mesochorus pectoralis, Ratz. I. 5 : 331.
Rhogas bicolor, Spin. B. 1 : 288.

Adaina (Leioptilus) microdactyla, Hb.

Ecphoropsis fuscipes, Hlmgr. I. 5 : 143.
Nepiera concinna, Hlmgr. I. 5 : 160.
Angitia fenestralis, Hlmgr. I. 5 : 192.
Apanteles adjunctus, Nees. B. 1 : 440.
,, *albipennis,* Nees. B. 1 : 460.

Alucita (Aciptilia) galactodactyla, Hb.

Ischnus nigricollis, Wesm. I. 1 : 283.
Phobocampa unicincta, Grav. I. 1 : 137.
Mesochorus sylvarum, Curtis I. 1 : 327.

Alucita pentadactyla, Linn.

Ischnus thoracicus, Grav. I. 1 : 284.

Orneodes hexadactyla, Linn.

Omorga multicincta, Grav. I. 5 : 156.
Angitia majalis, Grav. I. 5 : 191.
Bracon pectoralis, Wesm. B. 1 : 90.

CRAMBIDAE.

Chilo phragmitellus, Hb.

Pimpla melanocephala, Grav. I. 3 : 70. *cf.* 87.
Apanteles ferrugineus, Reinh. B. 1 : 414.

Crambus salinellus, Tutt.

Lissonota carbonaria, Hlmgr. I. 3 : 219.

Crambus contaminellus, Hb.

Lissonota lineata, Grav. I. 3 : 190.
,, *rufomedia,* Brdg. I. 3 : 214.
,, *carbonaria,* Hlmgr. I. 3 : 219.

Crambus geniculeus, Haw.

? *Lissonota lineata,* Grav. I. 3 : 190.

PHYCIDAE.

Myelois (Myelophila) cribrella, Hb. (**cribrum,** Schiff.)

Pimpla inquisitor, Scop. I. 3 : 63.
? ,, *roborator,* Fab. I. 3 : 57.
Ascogaster rufipes, Nees. B. 1 : 357.

Myelois ceratoniae, Zeller

Bracon brevicornis, Wesm. B. 1 : 139.
Phaneratoma dentata, Panz. B. 1 : 383.

Homoeosoma sinuella, Fab.

Bracon sinuella, Nees. B. 1 : 159.

Homoeosoma nimbella, Zeller

Exochus prosopius, Grav. I. 4 : 44.
Angitia rufipes, Grav. I. 5 : 189.
Apanteles lacteus, Nees. B. 1 : 449.

Homoeosoma nebulella, Hb.

Apanteles lacteus, Nees. B. 1 : 449.

Ephestia elutella, Hb.

Bracon brevicornis, Wesm. B. 1 : 139.

Ephestia kuehniella, Zeller

Nemeritis canescens, Grav. I. 5 : 134.
Bracon brevicornis, Wesm. B. 1 : 139.

Plodia interpunctella, Hb.

Ecphoropsis viennensis, Grav. I. 5 : 142.

Salebria (Phycis) betulae, Goeze.

Hemiteles areator, Panz. I. 2 : 133.
Pimpla inquisitor, Scop. I. 3 : 64.
Glypta ceratites, Grav. I. 3 : 149.
,, *flavolineata,* Grav. I. 3 : 168.
Limnerium geniculatum, Grav. I. 5 : 115.

Salebria (Rodophaea) formosa, Haw.

Chorinaeus flavipes, Brdg. I. 4 : 18.

Dioryctria abietella, D. & S.

Ephialtes carbonarius, Chr. I. 3 : 42.
,, *strobilorum,* Ratz. I. 3 : 42.
Pimpla inquisitor, Scop. I. 3 : 63.
Nemeritis transfuga, Grav. I. 5 : 131.
Bracon brevicornis, Wesm. B. 1 : 139.
Apanteles lacteus, Nees. B. 1 : 449.
,, *nigripes,* Ratz. B. 1 : 491.
Macrocentrus obscurator, Ratz. B. 2 : 241.

Phycita (Nephopteryx) spissicella, Fab. (**roborella,** Zinck.)

Labrorhychus tenuicornis, Grav. I. 5 : 249.
Macrocentrus abdominalis, Fab. B. 2 : 236.

Nephopteryx genistella, Dup.

Pimpla examinator, Fab. I. 3 : 99.
? *Lissonota halidaii,* Hlmgr. I. 3 : 212.
Syzeuctus maculatorius, Fab. I. 3 : 250.

Acrobasis (Rodophaea) consociella, Hb.

Pimpla turionellae, Linn. I. 3 : 103.
Glypta parvicornuta, Brdg. I. 3 : 149.
? *Lissonota halidaii,* Hlmgr. I. 3 : 212.
Exochus gravipes, Grav. I. 4 : 42.
Pristomerus vulnerator, Panz. I. 5 : 223.
Trichomma enecator, Rossi. I. 5 : 234.
Agrypon flaveolatum, Grav. I. 5 : 255.
Microgaster spretus, Marsh. B. 1 : 547.
Apanteles longicaudis, Wesm. Horsham, bred by K. G. Blair.
Macrocentrus thoracicus, Nees. B. 2 : 234.

Eurhodope (Rodophaea) advenella, Zinck.

Phanerotoma dentata, Panz. B. 1 : 383.

Eurhodope suavella, Zinck.

Limnerium geniculatum, Grav. I. 5 : 115.
Meteorus chrysophthalmus, Nees. B. 2 : 67.

Epischnia banksiella, Rich.

Angitia cerophaga, Grav. I. 5 : 195.

Galleria mellonella, Linn.

Ephialtes messor, Grav. I. 3 : 33.

TORTRICIDAE.

Cacoecia (Tortrix) podana, Scop.

Oedematopsis scabricula, Grav. Highgate, bred by K. G. Blair.
Macrocentrus abdominalis, Fab. B. 2: 236.
,, *thoracicus,* Nees. Hendon, bred by K. G. Blair.
,, *limbator,* Ratz. B. 2 : 240.
,, *marginator,* Nees. Hendon, bred by K. G. Blair.
Ascogaster rufipes, Nees. B. 1 : 358.

Cacoecia piceana, Linn.

Pezomachus modestus, Fst. I. 2 : 216.
,, *cursitans,* Grav. I. 2 : 231.
,, *geochares,* Fst. I. 2 : 237.
Pimpla examinator, Fab. I. 3 : 99–100.
,, *maculator,* Fab. I. 3 : 105.
? *Exochus alpinus,* Zett. I. 4 : 48.
Anilasta carbonaria, Ratz. I. 5 : 210.
Ascogaster rufidens, Wesm. B. 1 : 359.
Meteorus ictericus, Nees. B. 2 : 80.
? ,, *flaviceps,* Ratz. B. 2 : 132.

Cacoecia crataegana, Hb.

Coelichneumon lineator, Fab. I. 1 : 33.
Meteorus gracilis, Ratz. B. 2 : 133.
Eubadizon extensor, Linn. B. 2 : 137.
Macrocentrus thoracicus, Nees. B. 2 : 234.

Cacoecia decretana, Tr.

Chorinaeus cristator, Grav. I. 4 : 17.
Trichomma enecator, Rossi I. 5 : 234.

Cacoecia rosana, Linn.

Phaeogenes semivulpinus, Grav. I. 1 : 251.
Habrocryptus porrectorius, Fab. I. 1 : 318.
Pimpla inquisitor, Scop. I. 3 : 63.
,, *brevicornis,* Grav. I. 3 : 74.
,, *maculator,* Fab. I. 3 : 105.
,, *rufata,* Gmel. I. 3 : 112.
Phytodiaetus polyzonias, Forst. I. 3 : 242.
Omorga mutabilis, Hlmgr. I. 5 : 146.
,, *difformis,* Gmel. I. 5 : 148.
Angitia rufipes, Grav. I. 5 : 188.
,, *vestigialis,* Ratz. I. 5 : 200.
,, *exareolata,* Ratz. I. 5 : 203.
Rhogas testaceus, Spin. B. 1 : 296.
,, *circumscriptus,* Nees. B. 1 : 298.
Ascogaster quadridentatus, Wesm. B. 1 : 366.
? *Phaenocarpa ruficeps,* Nees. B. 1 : 410.
Apanteles xanthostigmus, Hal. B. 1 : 450.
,, *octonarius,* Ratz. B. 1 : 470.
Microplitis sordipes, Nees. B. 1 : 507.
? *Microdus dimidiator,* Nees. B. 1 : 585.
Meteorus rubriceps, Ratz. B. 2 : 109.
Eubadizon extensor, Linn. B. 2 : 137.
Macrocentrus abdominalis, Fab. B. 2 : 236.
,, *limbator,* Ratz. B. 2 : 240.
? *Opius pallidipes,* Wesm. B. 2 : 305.

Cacoecia sorbiana, Hb.

Pimpla nucum, Ratz. I. 3 : 84.

Cacoecia (Ptycholoma) lecheana, Linn.

Nemeritis gracilis, Grav. I. 5 : 133.

Cacoecia pronubana, Hb.

Oedematopsis scabricula, Grav. I. 3 : 271.
Meteorus ictericus, Nees. Eastbourne, bred by W. Rait-Smith.

Pandemis (Tortrix) heparana, Schiff.

Eclytus ornatus, Hlmgr. I. 4 : 266.
Agrypon flaveolatum, Grav. I. 5 : 255.
Ascogaster quadridentatus, Wesm. B. 1 : 366.
Apanteles lugens, Ratz. B. 1 : 493.
,, *caiae,* Bch. B. 3 : 178.
,, *gagates,* Nees. B. 3 : 179.
Meteorus pallidus, Nees. B. 3 : 219.
,, *cinctellus,* Nees. B. 3 : 220.
Macrocentrus abdominalis, Fab. B. 2 : 236.
,, *tenuis,* Ratz. B. 2 : 240.

Pandemis ribeana, Hb.

Habrocryptus porrectorius, Fab. I. 2 : 318.
Pimpla maculator, Fab. I. 3 : 105.

Phytodiaetus polyzonias, Forst. I. 3 : 242.
Mesochorus sylvarum, Curtis I. 5 : 327.
Ascogaster rufidens, Wesm. B. 1 : 359.
Macrocentrus abdominalis, Fab. B. 2 : 236.

Pandemis corylana, Fab.

Hormius moniliatus, Nees. B. 1 : 256.
Macrocentrus abdominalis, Fab. B. 2 : 236.

Tortrix costana, Fab.

Pimpla turionellae, Linn. I. 3 : 103.
Glypta monocerus, Grav. I. 3 : 147.
Oedematopsis scabricula, Grav. I. 3 : 270.
Angitia fenestralis, Hlmgr. I. 5 : 192.
Macrocentrus abdominalis, Fab. Chalfont, bred by K. G. Blair.

Tortrix viburnana, Fab.

Glypta genalis, Möll. I. 3 : 150.

Tortrix paleana, Hb.

Glypta bicornis, Boield I. 3 : 145.
Angitia rufipes, Grav. I. 5 : 189.

Tortrix viridana, Linn.

Phaeogenes stimulator, Grav. I. 1 : 260.
Diadromus candidatus, Grav. I. 1 : 267.
Hemiteles areator, Panz. I. 2 : 133.
Theronia atalantae, Poda I. 3 : 51.
Pimpla graminellae, Hlmgr. I. 3 : 60.
,, *inquisitor*, Scop. I. 3 : 63.
,, *pictipes*, Grav. I. 3 : 80.
,, *examinator*, Fab. I. 3 : 100.
,, *maculator*, Fab. I. 3 : 105.
,, *rufata*, Gmel. I. 3 : 112.
Glypta cicatricosa, Ratz. I. 3 : 168.
Phytodiaetus polyzonias, Forst. I. 3 : 242.
,, *coryphaeus*, Grav. I. 3 : 244.
Exochus globulipes, Desv. I. 4 : 37.
Chorinaeus cristator, Grav. Stanmore, bred by K. G. Blair.
Limnerium albidum, Gmel. I. 5 : 115.
Oncophanes lanceolator, Nees. B. 1 : 189.
Microgaster subcompletus, Nees. B. 1 : 537.
Meteorus cinctellus, Nees. B. 2 : 122.
Eubadizon extensor, Linn. B. 2 : 137.
Macrocentrus abdominalis, Fab. B. 2 : 236.

Tortrix diversana, Hb.

Eubadizon extensor, Linn. B. 2 : 137.

Tortrix fosterana, Fab.

Pimpla brevicornis, Grav. I. 3 : 75.
Glypta genalis, Möll. I. 3 : 150.
Oedematopsis scabricula, Grav. I. 3 : 273.
Angitia curvicauda, Hlmgr. Hendon, bred by K. G. Blair.
Apanteles impurus, Nees. B. 1 : 461.

Tortrix (Clepsis) rusticana, Tr.

Pimpla nucum, Ratz. I. 3 : 84.
,, *alternans*, Grav. I. 3 : 106.
Glypta fronticornis, Grav. I. 3 : 148.
Limnerium albidum, Grav. I. 5 : 115.
,, *geniculatum*, Grav. I. 5 : 116.

Sparganothis (Oenectra) pilleriana, Schiff.

Phaeogenes melanogonus, Gmel. I. 1 : 252.
Pimpla alternans, Grav. I. 3 : 106.
Labrorhychus clandestinus, Grav. I. 5 : 248.

Peronea mixtana, Hb.

Glypta parvicaudata, Brdg. I. 3 : 162.

Peronea comariana, Zell.

Copidosoma tortricis, Waterston. Holbeach, bred by H. Miles.

Peronea hastiana, Linn.

Phytodiaetus polyzonias, Forst. I. 3 : 242.
Angitia vestigialis, Ratz. I. 5 : 200.
Trichomma enecator, Rossi I. 5 : 234.
Agrypon anxium, Wesm. I. 5 : 257.
Microgaster globatus, Nees. B. 1 : 541.
Meteorus tenellus, Marsh. B. 2 : 123.

Peronea maccana, Tr.

Angitia interrupta, Hlmgr. I. 5 : 202.
Mesochorus thoracicus, Grav. I. 5 : 326.
,, *sylvarum*, Curtis I. 5 : 327.

Peronea sheperdana, Steph.

Microgaster tibialis, Nees. B. 1 : 544.

Peronea (Dictyopteryx) holmiana, Linn.

Rhogas circumscriptus, Nees. B. 1 : 298.
Ascogaster rufipes, Nees. B. 1 : 358.

Argyrotoxa (Dictyopteryx) bergmanniana, Linn.

Pristomerus vulnerator, Panz. I. 5 : 223.
Ascogaster quadridentatus, Wesm. B. 1 : 366.
Apanteles lugens, Ratz. B. 1 : 493.
?*Microdus dimidiator,* Nees. B. 1 : 585.
Meteorus ictericus, Nees. B. 3 : 80.

Argyroploce (Penthina) corticana, Hb.

Glypta incisa, Grav. I. 3 : 160.
Lissonota variabilis, Hlmgr. I. 3 : 213.

Argyroploce capraeana, Hb.

Glypta nigrina, Desv. I. 3 : 161.

Argyroploce pruniana, Hb.

Pimpla maculator, Fab. I. 3 : 105.
Meteorus rubriceps, Ratz. B. 2 : 109.

Argyroploce variegana, Hb.

Hemiteles necator, Grav. I. 2 : 130.
Glypta flavolineata, Grav. I. 3 : 168.
Omorga difformis, Gmel. I. 5 : 148.

Argyroploce dimidiana, Tr.

Platylabus pedatorius, Fab. I. 1 : 224.
Glypta punctifrons, Brdg. I. 3 : 157.
Exochus alpinus, Zett. I. 4 : 48.
Omorga ensator, Grav. I. 5 : 154.

Argyroploce gentiana, Hb.

Omorga mutabilis, Hlmgr. I. 5 : 146.
Angitia rufipes, Grav. I. 5 : 189.

Argyroploce (Antithesia) salicella, Linn.

Phytodiaetus ?coryphaeus, Grav. I. 3 : 244.

Argyroploce (Sericoris) rivulana, Scop.

Glypta ceratites, Grav. I. 3 : 149.

Argyroploce micana, Hb.

Pimpla inanis, Schr. I. 3 : 86.

Argyroploce (Euchromia) mygindana, Schiff.

Phaeogenes modestus, Wesm. I. 1 : 253.
Pimpla punctiventris, Thoms. I. 3 : 76.
Glypta ceratites, Grav. I. 3 : 149.
Angitia exareolata, Ratz. I. 5 : 203.
Ophion sp. I. 5 : 357.
Agathis brevisetis, Nees. B. 1 : 568.
Orgilus obscurator, Nees. B. 1 : 596.

Argyroploce rufana, Scop.

Phaeogenes semivulpinus, Grav. I. 1 : 251.

Argyroploce (Paedisca) profundana, Fab.

Lycorina triangulifera, Hlmgr. I. 3 : 142.

Spilonota (Hedya) ocellana, Fab.

Hemiteles ? necator, Grav. I. 2 : 130.
Glypta haesitator, Grav. I. 3 : 152.
,, *pedata,* Desv. I. 3 : 158.
Omorga ensator, Grav. I. 5 : 154.
Rhogas geniculator, Nees. B. 1 : 286.
Ascogaster quadridentatus, Wesm. B. 1 : 366.
Microdus rufipes, Nees. B. 1 : 587.
,, *clausthalianus,* Ratz. B. 1 : 580.
?*Meteorus flaviceps,* Ratz. B. 2 : 132.

Gypsonoma (Hedya) neglectana, Dup.

Angitia rufipes, Grav. I. 5 : 189.
Clinocentrus exsertor, Nees. B. 1 : 261.

Gypsonoma minutana, Hb.

Omorga ensator, Grav. I. 5 : 154.

Laspeyresia (Hedya) servillana, Dup.

Pimpla graminellae, Hlmgr. I. 3 : 60.
Cremastus decoratus, Grav. I. 5 : 59.

Laspeyresia (Semasia) rufillana, Wilk.

Glypta vulnerator, Grav. I. 3 : 153.
Microdus clausthalianus, Ratz. B. 1 : 580.

Laspeyresia (Coccyx) cosmophorana, Tr.

Pimpla brevicornis, Grav. I. 3 : 74.
,, *sagax,* Htg. I. 3 : 81.

Laspeyresia strobilella, Linn.

Ephialtes strobilorum, Ratz. I. 3 : 42.
Pimpla nucum, Ratz. I. 3 : 84.
Glypta similis, Brdg. I. 3 : 154.
Thersilochus moderator, Hlmgr. I. 5 : 53.
Cremastus pungens, Grav. I. 5 : 59.
Nemeritis cremastoides, Hlmgr. I. 5 : 132.
Bracon variegator, Nees. B. 1 : 100; 3 : 85.
,, *strobilorum,* Ratz. B. 1 : 168.

Bracon stabilis, Wesm. B. 3 : 79.
,, *roberti*, Wesm. B. 3 : 80.
Phanerotoma planifrons, Nees. B. 1 : 382.

Laspeyresia ustomaculana, Curtis

Angitia exareolata, Ratz. I. 5 : 203.
Ascogaster rufipes, Nees. B. 1 : 358.
Acoelius subfasciatus, Hal. B. 1 : 399.

Laspeyresia (Carpocapsa) splendana, Hb.

?*Pimpla nucum*, Ratz. I. 3 : 84.
Cremastus infirmus, Grav. I. 5 : 62.
Ascogaster quadridentatus, Wesm. B. 1 : 366.

Laspeyresia pomonella, Linn.

Glyphicnemis brevis, Grav. I. 2 : 69.
Ephialtes carbonarius, Chr. I. 3 : 42.
Pristomerus vulnerator, Panz. I. 5 : 223.

Laspeyresia (Opadia) funebrana, Tr.

Ascogaster quadridentatus, Wesm. B. 1 : 366.

Laspeyresia (Endopisa) nigricana, Steph.

Glypta haesitator, Grav. I. 3 : 152.
Ascogaster quadridentatus, Wesm. B. 1 : 366.

Laspeyresia (Stigmonota) dorsana, Fab.

Helcon intricator, Ratz. B. 2 : 227.
Macrocentrus flavipes, Ratz. B. 2 : 240.

Laspeyresia pactolana, Zell. (**cognatana**, Bar.)

Ephialtes extensor, Tasch. I. 3 : 33.

Laspeyresia leplastriana, Curt.

Pimpla maculator, Fab. I. 3 : 105.
Oedematopsis scabricula, Grav. I. 3 : 273.
Ascogaster rufipes, Nees. B. 1 : 357.

Laspeyresia corollana, Hb.

?*Diadromus subtilicornis*, Grav. I. 1 : 265.

Laspeyresia (Catoptria) microgramma, Guén.

Hemiteles hemipterus, Fab. I. 2 : 155.

Laspeyresia (Trycheris) aurana, Fab.

Omorga fasciata, Brdg. I. 5 : 157.

Notocelia (Spilonota) roborana, Tr.

Phytodiaetus polyzonias, Forst. I. 3 : 242.
,, *coryphaeus*, Grav. I. 3 : 244.

Notocelia (Aspis) udmanniana, Linn.

Pimpla inquisitor, Scop. I. 3 : 63.
Omorga mutabilis, Hlmgr. I. 5 : 146.
Chelonus rugosulus, Gour. B. 1 : 373.

Eucosma (Pardia) tripunctana, Fab.

Pimpla ruficollis, Grav. I. 3 : 58.
,, *inquisitor*, Scop. I. 3 : 63.
,, *maculator*, Fab. I. 3 : 105.
Ascogaster quadridentatus, Wesm. B. 1 : 366.
Microdus rufipes, Nees. B. 1 : 587.
Meteorus ictericus, Nees. B. 2 : 801.

Eucosma (Grapholitha) nigromaculana, Haw.

Hemiteles similis, Gmel. I. 2 : 150.

Eucosma subocellana, Don.

Omorga fasciata, Brdg. I. 5 : 157.
Meloboris crassicornis, Grav. I. 5 : 172.

Eucosma ramella, Linn.

Omorga mutabilis, Hlmgr. I. 5 : 146.

Eucosma (Phloeodes) tetraquetrana, Haw.

Phytodiaetus coryphaeus, Grav. I. 3 : 244.
Trichomma enecator, Rossi I. 5 : 234.
?*Microdus dimidiator*, Nees. B. 1 : 585.

Eucosma immundana, Fisch.

Pimpla inquisitor, Scop. I. 3 : 63.
Microgaster globatus, Nees. B. 1 : 541.
Eubadizon extensor, Linn. B. 2 : 137.

Eucosma rufimitrana, H.-S.

Pimpla ruficollis, Grav. I. 3 : 58.
Exochus tibialis, Hlmgr. I. 4 : 49.

Eucosma corticana, Hb.

?*Omorga mutabilis*, Hlmgr. I. 5 : 146.

Eucosma solandriana, Linn.

Cratichneumon magus, Wesm. I. 1 : 71.
Eclytus fontinalis, Hlmgr. I. 4 : 267.
Ascogaster quadridentatus, Wesm. B. 1 : 366.
Meteorus ictericus, Nees. B. 2 : 80.

Eucosma semifuscana, Steph.

Phytodiaetus polyzonias, Forst. I. 3: 242.
Exochus globulipes, Desv. I. 4: 37.
Macrocentrus marginator, Nees. B. 2: 233.
Meteorus ictericus, Nees. B. 3: 220.

Eucosma sordidana, Hb.

Agrypon canaliculatum, Hlmgr. I. 5: 254.

Eucosma (Ephippiphora) pflugiana, Haw.

Pimpla similis, Brdg. I. 3: 65.
,, *graminellae,* Hlmgr. I. 3: 60.
Glypta similis, Brdg. I. 3: 154.
,, *resinana,* Htg. I. 3: 156.
Limnerium xanthostigma, Grav. Bromley, bred by S. Jacobs.
?*Omorga mutabilis,* Hlmgr. I. 5: 146.
,, *molesta,* Grav. I. 5: 147.
?*Microdus clausthalianus,* Ratz. B. 1: 580.

Eucosma grandaevana, Zell.

Glypta similis, Brdg. I. 3: 153.

Eucosma foenella, Linn.

Glypta bifoveolata, Grav. I. 3: 166.
?*Pimpla nucum,* Ratz. I. 3: 84.
Omorga mutabilis, Hlmgr. I. 5: 146.

Eucosma trigeminana, Steph.

Apanteles albipennis, Nees. B. 1: 460.

Eucosma (Stigmonota) obscurana, Steph. **(ravulana,** H.-S.)

?*Agrypon geniculatum,* Hlmgr. I. 5: 259.

Eucosma (Catoptria) cana, Haw.

Glypta vulnerator, Grav. I. 3: 153.

Eucosma fulvana, Steph.

Omorga molesta, Grav. I. 5: 147.

Eucosma aemulana, Schläg.

Angitia parvula, Grav. I. 5: 179.
Ophion sp. I. 5: 358.
Chelonus inanitus, Linn. B. 1: 330.
Apanteles praetor, Nees. B. 1: 454.
,, *albipennis,* Nees. B. 1: 460.
,, *bicolor,* Nees. B. 1: 480.

Eucosma aspidiscana, Hb.

Oncophanes lanceolator, Nees. B. 1: 189.

Endothenia (Ephippiphora) nigricostana, Haw.

Glypta ceratites, Grav. I. 3: 149.
Omorga mutabilis, Hlmgr. I. 5: 146.

Polychrosis (Sericoris) euphorbiana, Freyer

Pimpla brevicornis, Grav. I. 3: 75.
Microgaster subcompletus, Nees. B. 1: 536.
,, *globatus,* Nees. B. 1: 541.

Polychrosis littoralis, Curtis

Ecphoropsis viennensis, Grav. I. 5: 142.
Angitia cylindrica, Brisch. Hendon, bred by K. G. Blair.
Apanteles sicarius, Marsh. B. 1: 467.

Polychrosis fuligana, Haw.

Angitia fenestralis, Hlmgr. I. 5: 192.

Phtheocroa rugosana, Hb.

Angitia interrupta, Hlmgr. I. 5: 202.

Cnephasia (Sciaphila) virgaureana, Tr.

Omorga mutabilis, Hlmgr. I. 5: 146.
Angitia rufipes, Grav. I. 5: 189.

Cnephasia bellana, Curtis **(penziana,** Thnbg.)

Theronia atalantae, Poda I. 3: 51.
Pimpla inquisitor, Scop. I. 3: 63.

Bactra lanceolana, Hb.

Glypta elongata, Hlmgr. I. 3: 146.

Ancylis (Phoxopteryx) derasana, Hb.

Microgaster subcompletus, Nees. B. 1: 537.

Ancylis mitterbacheriana, Schiff.

Phytodiaetus polyzonias, Forst. I. 3: 242.

Ancylis lactana, Fab.

Omorga ensator, Grav. I. 5: 153.

Euxanthis (Hypermecia) angustana, Hb.

Chorinaeus funebris, Grav. I. 4: 18.
Ascogaster canifrons, Wesm. Belmullet, Co. Mayo, bred W. Rait-Smith.

Batodes angustiorana, Haw.

Glypta ceratites, Grav. I. 3: 149.
Oedematopsis scabricula, Grav. I. 3: 272.

Olindia ulmana, Hb.

Pimpla graminellae, Hlmgr. I. 3 : 60.

Evetria (Retinia) posticana, Zett.

Pimpla ruficollis, Grav. I. 3 : 58.

Evetria buoliana, Schiff.

Pimpla ruficollis, Grav. I. 3 : 58.
,, *pomorum,* Ratz. Dunwich, bred by K. G. Blair.
,, *brevicornis,* Grav. I. 3 : 74.
,, *ovivora,* Brisch. Hendon, bred by K. G. Blair.
,, *sagax,* Htg. I. 3 : 81.
,, *colobata,* Grav. Limpsfield, bred by S. Jacobs.
,, *examinator,* Fab. I. 3 : 100.
,, *turionellae,* Linn. I. 3 : 103.
?*Lampronota melancholica,* Grav. I. 3 : 256.
Cremastus decoratus, Grav. I. 5 : 59–60.
,, *interruptor,* Grav. I. 5 : 61 *bis.*
Limnerium albidum, Gmel. I. 5 : 115.
Omorga difformis, Gmel. I. 5 : 148.
,, *ramidula,* Brisch. I. 5 : 149.
Pristomerus vulnerator, Panz. I. 5 : 223.
Euryproctus notatus, Grav. Hendon, bred by K. G. Blair.
Bracon discoideus, Wesm. B. 3 : 83.
Chelonus sulcatus, Nees. B. 1 : 342.
Orgilus obscurator, Nees. B. 1 : 596.
?*Caenocoelius agricolator,* Linn. B. 2 : 273.
Pteromalus sp. Westerham, bred by S. Jacobs.

Evetria pinicolana, Dbl.

Cratichneumon fugitivus, Grav. I. 1 : 65.
?*Meniscus pimplator,* Zett. I. 3 : 234.
Exetastes cinctipes, Retz. I. 3 : 295.
Orgilus obscurator, Nees. B. 3 : 194.

Evetria turionana, Hb.

Pimpla roborator, Fab. I. 3 : 57.
,, *ruficollis,* Grav. I. 3 : 59.
,, *sagax,* Htg. I. 3 : 81.
Glypta resinanae, Htg. I. 3 : 156.
Lissonota carbonaria, Hlmgr. I. 3 : 219.
Agrypon anomelas, Grav. I. 5 : 252.

Evetria pinivorana, Zell.

Pimpla ruficollis, Grav. I. 3 : 58.
Omorga ramidula, Brisch. I. 5 : 148.
,, *difformis,* Gmel. Westerham, bred by S. Jacobs.

Evetria resinella, Linn.

Ephialtes mesocentrus, Grav. I. 3 : 37.
,, *strobilorum,* Ratz. I. 3 : 42.
Pimpla ruficollis, Grav. I. 3 : 58.
,, *inquisitor,* Fab. I. 3 : 63.
,, *diluta,* Ratz. I. 3 : 68.
,, *brevicornis,* Grav. I. 3 : 74.
,, *sagax,* Htg. I. 3 : 81.
,, *inanis,* Schr. I. 3 : 86.
Clistopyga incitator, Fab. I. 3 : 139.
Glypta resinanae, Htg. I. 3 : 156.
,, *incisa,* Grav. I. 3 : 160.
,, *lugubrina,* Hlmgr. I. 3 : 163.
Lissonota variabilis, Hlmgr. I. 3 : 213.
?*Erromenus calcator,* Müll. I. 4 : 306.
Omorga ramidula, Brisch. I. 5 : 149.
Angitia chrysosticta, Gmel. I. 5 : 193.
,, *vestigialis,* Ratz. I. 5 : 200.
Orgilus obscurator, Nees. B. 1 : 596.

Evetria sylvestrana, Curtis

Omorga borealis, Zett. I. 5 : 151.

Hemimene (Dicrorampha) plumbagana, Tr.

Macrocentrus marginator, Nees. B. 2: 233.

Hemimene simpliciana, Haw.

Glypta bifoveolata, Grav. I. 3 : 166.

Hemimene tanaceti, Steph.

Microgaster subcompletus, Nees. B. 1: 536.

Lathronympha (Catoptria) hypericana, Hb.

Pimpla calobata, Grav. Bromley, bred by S. Jacobs.
Sigalphus caudatus, Nees. B. 1 : 319.

Phalonia (Eupoecilia) atricapitana, Steph.

Pezomachus palpator, Grav. I. 2 : 236.
Pimpla punctiventris, Thoms. I. 3 : 76.
Cremastus interruptor, Grav. I. 5 : 61.

Phalonia hybridella, Hb.

Glypta lugubrina, Hlmgr. I. 3 : 163.

Phalonia ambiguella, Hb.

Hemiteles areator, Panz. I. 2 : 133.
Spilocryptus abbreviator, Fab. I. 2 : 279.
Pimpla turionellae, Linn. I. 3 : 103.
Omorga mutabilis, Hlmgr. I. 5 : 145.

Phalonia curvistrigana, Wilk.

Macrocentrus infirmus, Nees. B. 2 : 238.

Phalonia alismana, Rag. (**udana,** Guén.)

Glypta pedata, Desv. I. 3 : 158.
Angitia interrupta, Hlmgr. I. 5 : 202.
Agrypon anixum, Wesm. I. 5 : 257.

Phalonia manniana, Fisch. (**notulana,** Zell.)

Glypta rufata, Brdg. I. 3 : 165.
Earinus zonatus, Marsh. B. 1 : 589.

Phalonia flaviciliana, Wilk.

Pimpla inquisitor, Scop. I. 3 : 64.
,, *brevicornis,* Grav. I. 3 : 75.
,, *punctiventris,* Thoms. I. 3 : 76.

Phalonia roseana, Haw.

Agathis nigra, Nees. B. 1 : 565.

Phalonia ciliella, Hb.

Pimpla nucum, Ratz. I. 3 : 84.
Bracon erraticus, Wesm. B. 1 : 106.
Apanteles laetus, Marsh. B. 1 : 438.
,, *albipennis,* Nees. B. 1 : 460.

Phalonia (Chrosis) rutilana, Hb.

Agathis brevisetis, Nees. B. 1 : 568.

Phalonia (Argyrolepia) zephyrana, Tr.

Cremastus interruptor, Grav. I. 5 : 61.
Bracon minutator, Fab. B. 1 : 96.

Phalonia maritimana, Guén.

Glypta rubicunda, Bdg. I. 3 : 150.

Phalonia smeathmaniana, Fab.

Microgaster globatus, Nees. B. 1 : 541.

Spatalistis (Chrosis) bifasciana, Hb.

Pimpla turionellae, Linn. I. 3 : 101.
Omorga ensator, Grav. I. 5 : 154.

Lozopera (Conchylis) francillana, Fab.

Apanteles albipennis, Nees. B. 1 : 460.

Lozopera dilucidana, Steph.

Apanteles decorus, Hal. B. 1 : 445.
,, *emarginatus,* Nees. B. 1 : 455.

TINEIDAE.

Chimabache (Diurnea) fagella, Fab.

Glypta ceratites, Grav. I. 3 : 149.
Apanteles xanthostigmus, Hal. B. 1 : 450.

Talaeporia pseudobombycella, Hb.

Hemiteles areator, Panz. I. 2 : 133.
Pezomachus palpator, Grav. I. 2 : 236.
Cryptus spiralis, Fourc. I. 2 : 305.
Caenocryptus rufiventris, Grav. I. 2 : 322.
Hemichneumon elongatus, Ratz. Gt. Missenden, bred by K. G. Blair.

Pachythelia (Psyche) villosella, Ochs.

Cremastus geminus, Grav. I. 5 : 56.
,, *bellicosus,* Grav. I. 5 : 57.
Trichomma enecator, Rossi I. 5 : 234.
Agrypon insignis, Fst. I. 5 : 258.

Pachythelia opacella, H.-S.

Pimpla arctica, Zett. I. 3 : 98.
,, *examinator,* Fab. I. 3 : 100.
Angitia nana, Grav. I. 5 : 183.

Sterrhopteryx (Psyche) hirsutella, Hb. (**fusca,** Haw. ; **calvella,** Ochs.)

Hemiteles areator, Panz. I. 2 : 133.
,, *similis,* Gmel. I. 2 : 150.
Pezomachus agilis, Grav. I. 2 : 217.
Spilocryptus abbreviator, Fab. I. 2 : 280.
Pimpla examinator, Fab. I. 3 : 100.
,, *maculator,* Fab. I. 3 : 105.
Cremastus infirmus, Grav. I. 5 : 62 *bis.*

Epichnopteryx pulla, Esper (**radiella,** Curtis)

Pezomachus instabilis, Fst. I. 2 : 228.
Macrocentrus abdominalis, Fab. B. 2 : 236.

Proutia (Fumea) betulina, Zell.

Omorga mutabilis, Hlmgr. I. 5 : 146.
Angitia cylindrica, Brisch. I. 5 : 196.
Apanteles sp. I. 5 : 196.

Fumea casta, Pall. (**nitidella,** Hb. ; **intermediella,** Braund)

Phaeogenes spp. I. 1 : 243.
Panargyrops tenuipes, Grav. I. 2 : 103.

Hemiteles bicolorinus, Grav. I. 2 : 131.
,, *areator*, Panz. I. 2 : 133.
,, *tristator*, Grav. I. 2 : 148.
,, *imbecillus*, Grav. I. 2 : 159.
Pezomachus corruptor, Fst. I. 2 : 225.
,, *geochares*, Fst. I. 2 : 237.
,, *indagator*, Fst. I. 2 : 238.
Spilocryptus abbreviator, Fab. I. 2 : 279.
Pimpla examinator, Fab. I. 3 : 100.
,, *maculator*, Fab. I. 3 : 105.
Lissonota obsoleta, Brdg. I. 3 : 197.
,, *nigridens*, Thoms. I. 3 : 224.
Cremastus bellicosus, Grav. I. 5 : 57.
Omorga fasciata, Brdg. I. 5 : 157.
,, *ensator*, Grav. Gt. Missenden, bred by K. G. Blair.
Angitia nana, Grav. I. 5 : 183.
,, *lateralis*, Grav. I. 5 : 194.
,, *chrysosticta*, Gmel. I. 5 : 194.
?*Polysphincta percontatoria*, Müll. I. 3 : 130.
Microplitis tristis, Nees. B. 3 : 182.

Luffia lapidella, Goeze

Pimpla brevicornis, Grav. I. 3 : 75.
Omorga ensator, Grav. I. 5 : 154.
Angitia tibialis, Grav. I. 5 : 198.

Teichobia (Psychoides) verhuellella, St.

Apanteles triangulator, Wesm. B. 1 : 478.
,, *bicolor*, Nees. B. 1 : 480.

Solenobia inconspicuella, St.

Apanteles sodalis, Hal. B. 1 : 459.

Narycia (Xysmatodoma) melanella, Haw.

Ascogaster annularis, Nees. B. 1 : 352.

Scardia boleti, Fab.

Microdus calculator, Fab. B. 1 : 583.

Tinea (Scardia) parasitella, Hb.

Microdus calculator, Fab. B. 1 : 583.

Tinea cloacella, Haw.

Lissonota segmentator, Fab. I. 3 : 222.

Tinea arcella, Fab.

?*Thersilochus jocator*, Fab. I. 5 : 50.

Tinea (Tinea) misella, Zell.

Apanteles vipio, Reinh. B. 1 : 452.

Tinea pellionella, Linn.

Cremylus rubiginosus, Nees. B. 1 : 254.

Monopis (Blabophanes) rusticella, Hb.

?*Phygadeuon rusticellae*, Brdg. I. 2 : 82.
?*Hemiteles floricolator*, Grav. I. 2 : 145.

Tineola biselliella, Hb.

Hemiteles cingulator, Grav. I. 2 : 135.

Meessia richardsoni, Wlsm.

Angitia apostata, Grav. I. 5 : 188.

Lampronia quadripunctella, Fab.

Omorga ensator, Grav. I. 5 : 154.

Lampronia praelatella, Schiff.

Omorga melanosticta, Grav. I. 5 : 153.

Eriocrania (Micropteryx) semipurpurella, Steph.

Phanomeris dimidiata, Nees. B. 3 : 87.

Mnemonica (Micropteryx) unimaculella, Zett.

Thersilochus saltator, Fab. I. 5 : 54.

Adela rufimitrella, Scop.

Agrypon canaliculatum, Hlmgr. I. 5 : 254.

HYPONOMEUTIDAE.

Swammerdammia caesiella, Hb.

Angitia tibialis, Grav. I. 5 : 198.
Apanteles xanthostigmus, Hal. B. 1 : 450.

Swammerdammia lutarea, Haw.

Apanteles xanthostigmus, Hal. B. 1 : 450.

Swammerdammia pyrella, Vill.

Apanteles exilis, Hal. Hendon, bred by K. G. Blair.

Scythropia crataegella, Linn.

Hemiteles bicolorinus, Grav. I. 2 : 131.
Mesochorus fuscicornis, Brisch. I. 5 : 324.

Hyponomeuta vigintipunctata, Retz.

Chorinaeus tricarinatus, Hlmgr. I. 4 : 19.
Omorga ensator, Grav. Pinner, bred by K. G. Blair.

Hyponomeuta plumbella, Schiff.

Omorga ensator, Grav. I. 5 : 154.

Hyponomeuta padella, Linn.

Ichneumon rubellus, Grav. Kollar, Treat. Ins. transl. Loudon, 1840, p. 229.

Platylabus nigricollis, Wesm. I. 1 : 233.
Herpestomus brunnicornis, Grav. I. 1 : 240.
Phoeogenes stimulator, Grav. I. 1 : 260.
Hemiteles areator, Panz. I. 2 : 133.
Pezomachus instabilis, Fst. I. 2 : 228.
Pimpla examinator, Fab. I. 3 : 100.
,, *maculator*, Fab. I. 3 : 105.
Chorinaeus tricarinatus, Hlmgr. I. 4 : 19.
Polyclistus mansuetor, Grav. I. 4 : 26.
Exochus gravipes, Grav. I. 4 : 42.
?*Mesoleius multicolor*, Grav. I. 4 : 168.
Plectiscus canaliculatus, Fst. I. 5 : 10.
Limnerium albidum, Gmel. I. 5 : 115.
Angitia majalis, Grav. I. 5 : 191.
,, *chrysosticta*, Gmel. I. 5 : 193.
Labrorhychus tenuicornis, Grav. I. 5 : 249.
Mesochorus confusus, Hlmgr. I. 5 : 323.
,, *crassimanus*, Hlmgr. I. 5 : 328.
,, *anomalus*, Hlmgr. Kendal, bred by K. G. Blair.
Ascogaster rufipes, Becs. B. 1 : 358.
,, *quadridentatus*, Wesm. B. 1 : 366.
Apanteles sericeus, Nees. B. 1 : 424.
,, *tenebrosus*, Wesm. B. 1 : 457.
,, *lateralis*, Hal. B. 1 : 488.

Hyponomeuta cognatella, Tr. (**evonymella,** Scop.; **cagnagella,** Hb.)

Herpestomus brunnicornis, Grav. I. 1 : 240.
Pimpla examinator, Fab. I. 3 : 100.
,, ? *inquisitor*, Scop. I. 3 : 63.
,, *maculator*, Fab. I. 3 : 105.
Ephialtes ?*tuberculatus*, Fourc. I. 3 : 39.
Orthocentrus stigmaticus, Hlmgr. I. 4 : 56.
Angitia rufipes, Grav. I. 5 : 189.
,, *chrysosticta*, Gmel. I. 5 : 193.
Agrypon flaveolatum, Grav. I. 5 : 255.
Omorga curvicauda, Hlmgr. Knockholt, bred by K. G. Blair.

Hyponomeuta evonymella, Linn. (**padi,** Zell.)

Herpestomus brunnicornis, Grav. I. 1 : 240.
Hemiteles areator, Panz. I. 2 : 133.
Pezomachus hyponomeutae, Brdg. I. 2 : 238.
Pimpla examinator, Fab. I. 3 : 100.
Cremastus interruptor, Grav. I. 5 : 61.
Angitia chrysosticta, Gmel. I. 5 : 193.
Labrorhychus clandestinus, Grav. I. 5 : 248.
,, *tenuicornis*, Grav. I. 5 : 249.
Agrypon canaliculatum, Hlmgr. I. 5 : 254.
Mesochorus vittator, Hlmgr. I. 5 : 329.
,, *brevipetiolatus*, Ratz. I. 5 : 332.
Apanteles evonymellae, Bche. B. 1 : 491.
,, *medianus*, Ratz. B. 1 : 493.
,, *emarginatus*, Nees. B. 3 : 178.
Macrocentrus abdominalis, Fab. B. 2 : 236.

Ethmia (Anesychia) pusiella, Roem.

Erromenus frenator, Grav. I. 4 : 310.

Ethmia funerella, Fab.

? *Ascogaster rufipes*, Nees. B. 1 : 358.

PLUTELLIDAE.

Ediophasia messingiella, Fisch.

Omorga lugubrina, Hlmgr. I. 5 : 152.

Plutella maculipennis, Curtis (**cruciferarum,** Zell.)

Limnerium paniscus, Grav. I. 5 : 119.
Angitia majalis, Grav. I. 5 : 191.
,, *armillata*, Grav. I. 5 : 197.
,, *nana*, Grav. Hendon, bred by K. G. Blair.
Omorga cerophaga, Grav. Hendon, bred by K. G. Blair.
,, *borealis*, Zett. Hendon, bred by K. G. Blair.

Plutella porrectella, Linn.

Omorga faunus, Grav. I. 5 : 147.
Angitia apostata, Grav. I. 5 : 188.
,, *majalis*, Grav. I. 5 : 190.
Apanteles bicolor, Nees. B. 1 : 480.

Cerostoma radiatella, Don.

Labrorhychus clandestinus, Grav. I. 5 : 248.
Agrypon flaveolatum, Grav. I. 5 : 256.

Cerostoma xylostella, Linn.

Colastes braconius, Hal. Chalfont, bred by K. G. Blair.
Apanteles vitripennis, Hal. Hendon, bred by K. G. Blair.

Cerostoma costella, Fab.

Hemiteles areator, Panz. I. 2 : 133.
Labrorhychus clandestinus, Grav. I. 5 : 248.

Cerostoma sylvella, Linn.

Apanteles sp. Chalfont, bred by K. G. Blair.

Orthotelia sparganella, Thnbg.

Phaeogenes stipator, Wesm. I. 1 : 249.
Meloboris rufiventris, Grav. I. 5 : 171.
Microgaster russatus, Hal. B. 1 : 530.

GELECHIIDAE.

Carcina (Phibalocera) quercana, Fab.

Campoplex pugillator, Linn. I. 5 : 79.
Batysthomus funestus, Hal. B. 3 : 258.

Exaeretia allisella, St.

Hemiteles castaneus, Grav. I. 2 : 137.

Depressaria umbellana, Steph.

Melanichneumon sanguinator, Rossi I. 1 : 83.

Depressaria atomella, Haw. (**scopariella,** Hein.)

Pimpla maculator, Fab. I. 3 : 105.
Chorinaeus tricarinatus, Hlmgr. I. 4 : 19.
Exochus spiracularis, Thoms. I. 4 : 38.
Microgaster tibialis, Nees. I. 4 : 38.
Angitia cerophaga, Grav. I. 5 : 195.
Microdus clausthalianus, Ratz. B. 1 : 580.

Depressaria assimilella, Tr.

Angitia apostata, Grav. I. 5 : 188.

Depressaria alstroemeriana, Clerck

Macrocentrus abdominalis, Fab. B. 2: 236.

Depressaria hypericella, Hb.

Angitia fenestralis, Hlmgr. I. 5 : 192.

Depressaria liturella, Hb.

Orgilus obscurator, Nees. B. 1 : 596.

Depressaria conterminella, Zell.

Orgilus obscurator, Nees. B. 1 : 596.

Depressaria angelicella, Hb.

? *Homocidus tarsatorius,* Panz. I. 4 : 98.
Pygostolus sticticus, Fab. B. 2 : 169.
Macrocentrus marginator, Nees. B. 2: 233.

Depressaria carduella, Hb.

Apanteles emarginatus, Nees. B. 1 : 455.

Depressaria applana, Fab.

Mesochorus splendidulus, Grav. I. 5 : 306.
Rhogas testaceus, Spin. B. 1 : 296.
Macrocentrus thoracicus, Nees. B. 2 : 234.

Depressaria depressella, Hb.

Platylabus dimidiatus, Grav. I. 1 : 234.
Acanthocryptus flagitator, Rossi I. 2 : 56.

Depressaria chaerophylli, Zell.

Apanteles emarginatus, Nees. B. 1 : 455.
Macrocentrus thoracicus, Nees. B. 2 : 234.

Depressaria nervosa, Haw.

Phaeogenes melanogonus, Gmel. I. 1: 252.
Dicaelotus pumilus, Grav. I. 1 : 275.
Glyphicnemis profligator, Fab. I. 2 : 65.
Hemiteles floricolator, Grav. I. 2 : 145.
Habrocryptus porrectorius, Fab. I. 2 : 317.
Sagaritis femoralis, Grav. I. 5 : 96.
Apanteles emarginatus, Nees. B. 1 : 455.
Agathis anglica, Marsh. B. 1 : 566.
Eubadizon extensor, Linn. B. 2 : 137.
Macrocentrus thoracicus, Nees. B. 2 : 234.

Depressaria badiella, Hb.

Cremastus decoratus, Grav. I. 5 : 59.

Depressaria heracleana, De Geer

Barichneumon heracleanae, Brdg. I. 1: 93.
,, *lepidus,* Grav. I. 1 : 102.
,, *derogator,* Wesm. I. 1 : 292.
,, *sexalbatus,* Wesm. Box Hill, bred by T. R. Eagles.
?*Cratichneumon coruscator,* Linn. I. 1 : 66.
Platylabus dimidiatus, Grav. I. 1 : 234.
Acanthocryptus flagitator, Rossi I. 2 : 56.
,, *hopei,* Morley I. 2 : 57.
Pimpla graminellae, Hlmgr. I. 3 : 60.
,, *turionellae,* Linn. I. 3 : 102.
Chorinaeus funebris, Grav. I. 4 : 18.
Limnerium geniculatum, Grav. I. 5 : 116.
Litomastix truncatellus, Dalm. Box Hill, bred by T. R. Eagles.

Chelaria (Psoricoptera) gibbosella, Zell.

Eubadizon extensor, Linn. B. 2 : 137.

Gelechia pinguinella, Tr.

Apanteles hoplites, Ratz. B. 3 : 178.
Macrocentrus limbator, Ratz. B. 2 : 240.

Gelechia hippophaella, Sch.

Angitia rufipes, Grav. I. 5 : 189.

Gelechia lentiginosella, Zell.

Lissonota fletcheri, Brdg. I. 3 : 193.
Limnerium renominatum, Morley, I. 5 : 121.

Gelechia mulinella, Zell.

Hemiteles subannulatus, Brdg. I. 2 : 169.
Bracon stabilis, Wesm. B. 1 : 97.

Epithectis (Brachmia) mouffetella, Sch.

Angitia exareolata, Ratz. I. 5 : 203.

Epithectis (Bryotropha) domestica, Haw.

Meteorus consors, Ruthe B. 2 : 110.

Platyedra (Gelechia) vilella, Zell.

Angitia elishae, Brdg. I. 5 : 184.

Phthorimaea salicorniae, Her.

Omorga ensator, Grav. I. 5 : 154.
Apanteles sp. I. 5 : 154.

Phthorimaea (Lita) acuminatella, Sircom.

Orgilus obscurator, Nees. B. 1 : 596.
Microdus tumidulus, Nees. B. 1 : 581.

Phthorimaea artemisiella, Tr.

Lissonota variabilis, Hlmgr. I. 3 : 213.

Phthorimaea tricolorella, Haw.

Apanteles albipennis, Nees. B. 1 : 460.

Phthorimaea obsoletella, Fisch.

Angitia rufipes, Grav. I. 5 : 189.

Phthorimaea instabilella, Dougl.

Omorga ensator, Grav. I. 5 : 154.
Apanteles viminetorum, Wesm. B. 1 : 458.

Phthorimaea plantaginella, St.

Dicaelotus pumilus, Grav. I. 1 : 275.

Telphusa (Teleia) proximella, Hb.

Omorga ensator, Grav. I. 5 : 154.

Telphusa notatella, Hb.

Exochus fletcheri, Brdg. I. 4 : 50.
Omorga ensator, Grav. I. 5 : 154.
Nepiera concinna, Hlmgr. I. 5 : 160.
Angitia variabilis, Brdg. I. 5 : 205.
Mesochorus crassicrus, Thoms. I. 5 : 324.
Stictopisthus laticeps, Thoms. I. 5 : 337.

Telphusa vulgella, Hb.

Hemiteles areator, Panz. I. 2 : 133.
Ascogaster rufidens, Wesm. B. 1 : 359.

Exoteleia (Teleia) dodecella, Linn.

Cremastus interruptor, Grav. I. 5 : 61.

Recurvaria leucatella, Clerck

Oncophanes lanceolator, Nees. B. 1 : 189.
Apanteles longicaudis, Wesm. B. 1 : 468.

Aristotelia (Nannodia) stipella, Hb.

Omorga borealis, Hlmgr. I. 5 : 151.
,, *lugubrina,* Hlmgr. I. 5 : 152.
Labrorhychus tenuicornis, Grav. I. 5 : 249.

Aristotelia hermannella, Fab.

Apanteles bicolor, Nees. B. 1 : 480.
Agathis rufipalpis, Nees. B. 1 : 567.

Aristotelia (Ptocheuusa) inopella, Zell. **(paupella,** St.)

Pimpla nucum, Ratz. I. 3 : 84.
Omorga faunus, Grav. I. 5 : 147.
Angitia cylindrica, Brisch. I. 5 : 196.
Apanteles halidaii, Marsh. B. 1 : 464.
Microdus tumidulus, Nees. B. 1 : 581.

Aristotelia brizella, Tr.

Apanteles albipennis, Nees. B. 1 : 460.

Aristotelia (Doryphora) pulveratella, H.-S.

Pimpla brevicornis, Grav. I. 3 : 74.

Aristotelia tetragonella, St.

Angitia fenestralis, Hlmgr. I. 5 : 192.

Stomopteryx vinella, Bankes

Angitia cylindrica, Brisch. I. 5 : 196.

Stomopteryx (Anacampsis) albipalpella, H.-S.

Hemiteles areator, Panz. I. 2 : 133.

Stomopteryx sangiella, St.

Angitia interrupta, Hlmgr. I. 5 : 202.

Stomopteryx anthyllidella, Hb.

Pimpla nucum, Ratz. I. 3 : 84.
Pectenella latungula, Thoms. I. 5 : 174.
Orgilus obscurator, Nees. B. 1 : 596.

Anacampsis (Tachyptilia) populella, Clerck

Pimpla pictipes, Grav. I. 3 : 80.
,, *inanis,* Schr. I. 3 : 86.
,, *rufata,* Gmel. I. 3 : 112.
?*Lycorina triangulifera,* Hlmgr. I. 3 : 141.
Exochus podagricus, Grav. I. 4 : 35.
,, *tibialis,* Hlmgr. I. 4 : 49.
? ,, *lentipes,* Grav. I. 4 : 49.
Omorga multicincta, Grav. I. 5 : 156.
Apanteles hoplites, Ratz. B. 1 : 443.
Microgaster globatus, Nees. B. 1 : 541.
,, *tibialis,* Nees. B. 1 : 544.
Macrocentrus thoracicus, Nees. B. 2: 234.
,, *limbator,* Ratz. B. 2 : 240.

Campsolechia (Tachyptilia) temerella, Zell.

Glypta teres, Grav. I. 3 : 157.

Metzneria lappella, Linn.

Agathis malvacearum, Latr. B. 1 : 564.

Metzneria (Parasia) metzneriella, St.

Glypta resinanae, Htg. I. 3 : 156.

Metzneria carlinella, St.

Bracon luteator, Spin. B. 1 : 90.
Agathis malvacearum, Latr. B. 1 : 564.

Paltodora (Cleodora) cytisella, Curtis

Agathis brevisetis, Nees. B. 1 : 568.

Telephila (Hypsilophus) schmidiellus, Heyd.

Chorinaeus cristator, Grav. I. 4 : 17.

Nothris verbascella, Hb.

Exochus curvator, Fab. I. 4 : 37.
,, *congener,* Hlmgr. I. 4 : 38.
Cremastus decoratus, Grav. I. 5 : 59.
,, *interruptor,* Grav. I. 5 : 61.
Omorga difformis, Gmel. I. 5 : 148.
Angitia rufipes, Grav. I. 5 : 188.

Oecophora (Harpella) geoffrella, Linn.

Meteorus pulchricornis, Wesm. B. 2 : 108.

Hypercallia christiernana, Linn. (**citrinalis,** Scop.)

Angitia fenestralis, Hlmgr. I. 5 : 192.

Dasycera sulphurella, Fab.

Biosteres carbonarius, Nees. Hendon, bred by K. G. Blair.

Schiffermuelleria (Oecophora) augustella, Hb.

Campoplex zonellus, Fst. I. 5 : 90.

Chirocampa (Oecophora) lambdella, Don.

? *Ascogaster annularis,* Nees. B. 1 : 352.

Borkhausenia (Oecophora) pseudospretella, St.

Acrotomus sexcinctus, Grav. Hendon, bred by K. G. Blair.
Ascogaster rufidens, Wesm. Hendon, bred by K. G. Blair.

Endrosis lactella, Sch. (**fenestrella,** Scop.)

Hemiteles bicolorinus, Grav. I. 2 : 131.
? *Angitia chrysosticta,* Gmel. I. 5 : 194.
Bracon variegator, Nees. B. 1 : 100.

Scythris (Butalis) grandipennis, Haw.

Omorga ensator, Grav. I. 5 : 154.

Scythris fuscoaenea, Haw.

Apanteles butalidis, Marsh. B. 1 : 451.

Scythris senescens, St.

Dicaelotus cameroni, Brdg. I. 1 : 275.

Scythris variella, Steph.

Cremastus interruptor, Grav. I. 5 : 61.

Atemelia torquatella, Linn.

Apanteles longicaudis, Wesm. B. 1 : 468.

GLYPHIPTERYGIDAE.

Simaethis fabriciana, Linn.

Pimpla turionellae, Linn. I. 3 : 103.
Exochus podagricus, Grav. I. 4 : 35.
Angitia majalis, Grav. I. 5 : 191.
,, *fenestralis,* Hlmgr. I. 5 : 192.
Mesochorus confusus, Hlmgr. I. 5 : 323.
,, *vittator,* Hlmgr. I. 5 : 329.
Microplitis sp. I. 5 : 323.
Apanteles lateralis, Hal. B. 1 : 488.

Choreutis myllerana, Fab.

Angitia fenestralis, Hlmgr. I. 5 : 192.
,, *rufata,* Brdg. I. 5 : 202.
Mesochorus vitticollis, Hlmgr. Byfleet, bred by K. G. Blair.

Acrolepia granitella, Tr.

Hemiteles pedestris, Fab. I. 2 : 139.
Angitia cylindrica, Brisch. I. 5 : 196.

Acrolepia pygmaeana, Haw.

Apanteles infimus, Hal. B. 1 : 462.
,, *ensiformis,* Ratz. B. 1 : 491.

Glyphipteryx haworthana, Steph.

Pimpla nucum, Ratz. I. 3 : 84.
Omorga tumidula, Grav. I. 5 : 155.

Douglasia oenerostomella, St.

Apanteles albipennis, Nees. B. 1 : 460.

ARGYRESTHIIDAE.

Argyresthia nitidella, Fab.

Pimpla maculator, Fab. I. 3 : 105.
Angitia chrysosticta, Gmel. I. 5 : 193.
Meteorus versicolor, Wesm. B. 2 : 117.

Argyresthia conjugella, Zell.

Microgaster politus, Marsh. B. 1 : 546.

Argyresthia goedartella, Linn.

Apanteles decorus, Hal. B. 1 : 445.

GRACILARIIDAE.

Gracilaria stigmatella, Fab.

Pimpla maculator, Fab. I. 3 : 105.
Ecphoropsis viennensis, Grav. I. 5 : 142.
Angitia cerophaga, Grav. I. 5 : 195.
,, *gracilis,* Brdg. I. 5 : 199.

Gracilaria semifascia, Haw.

Chorinaeus talpa, Hal. I. 4 : 20.
Apanteles lacteus, Marsh. B. 1 : 438.
,, *xanthostigmus,* Hal. B. 1 : 450.
,, *bicolor,* Nees. B. 1 : 480.
,, *lautellus,* Marsh. B. 1 : 483.

Gracilaria tringipennella, Zell.

Angitia elishae, Brdg. I. 5 : 184.
Apanteles bicolor, Nees. B. 1 : 480.

Gracilaria syringella, Fab.

? *Pimpla inquisitor,* Scop. I. 3 : 64.
Nemeritis transfuga, Grav. I. 5 : 131.
Angitia coleophorarum, Ratz. I. 5 : 180.
,, *chrysosticta,* Gmel. I. 5 : 193.
Anilasta tricincta, Hlmgr. I. 5 : 214.
Ascogaster rufidens, Wesm. B. 1 : 359.
Apanteles dilectus, Hal. B. 1 : 446.
,, *impurus,* Nees. B. 1 : 461.
,, *fuliginosus,* Wesm. B. 1 : 468.
,, *bicolor,* Nees. B. 1 : 480.
,, *viminetorum,* Wesm. B. 3 : 178.

Gracilaria phasianipennella, Hb.

Hemiteles laevigatus, Ratz. I. 2 : 153.
Pezomachus instabilis, Fst. I. 2 : 228.
? *Homocidus elegans,* Grav. I. 4 : 110.
Angitia tibialis, Grav. I. 5 : 198.
Mesochorus crassicrus, Thoms. I. 5 : 325.

Gracilaria auroguttella, Steph.

Hemiteles laevigatus, Ratz. I. 2 : 153.

Gracilaria cuculipennella, Hb.

Hemiteles laevigatus, Ratz. I. 2 : 153.
Angitia gracilis, Brdg. I. 5 : 199.

Parecopta (Gracilaria) ononidis, Zell.

Apanteles ononidis, Marsh. B. 1 : 461.
,, *halidaii,* Marsh. B. 1 : 464.

Cataplectica (Oecophora) fulviguttella, Zell.

Bracon obscurator, Nees. B. 1 : 159.

Ornix betulae, St.

Colastes braconius, Hal. B. 1 : 188.

Ornix scoticella, St.

Angitia elishae, Brdg. I. 5 : 184.
Acoelius subfasciatus, Hal. B. 1 : 400.

COLEOPHORIDAE.

Goniodoma limoniella, St. (**auroguttella,** St.)

Apanteles halidaii, Marsh. B. 1 : 464.

Coleophora deauratella, Zell.

Tetrastichus eudemus, Walk. Ent. Mon. Mag. **23 :** 214.

Coleophora alcyonipennella, Kol.

Orgilus obscurator, Nees. B. 1 : 596.

Coleophora frischella, Linn. (**melilotella,** Scott)

Pezomachus palpator, Grav. I. 2 : 236.
Pimpla brevicornis, Grav. I. 3 : 75.

Coleophora ahenella, Wk.

Acoelius subfasciatus, Thoms. B. 1 : 399.

Coleophora vibicella, Hb.

Pezomachus pulicarius, Fab. I. 2 : 218.
,, *palpator,* Grav. I. 2 : 236.
Angitia rufipes, Grav. I. 5 : 188.
Orgilus rugosus, Nees. B. 3 : 195.

Coleophora conspicuella, Zell.

Spinolia maculipennis, Grav. I. 2 : 115.

Coleophora pyrrhulipennella, Zell.

Pezomachus steveni, Grav. I. 2 : 227.
Omorga borealis, Zett. I. 5 : 150.
Angitia fenestralis, Hlmgr. I. 5 : 192.

Coleophora albicosta, Haw.

Limneria volubilis, Hlmgr. Ent. Mon. Mag. **23 :** 214.

Coleophora anatipennella, Hb.

Hemiteles bicolorinus, Grav. I. 2 : 131.
,, *areator,* Panz. I. 2 : 133–134.
Pimpla maculator, Fab. I. 3 : 105.

Coleophora betulella, Hein. (**ibipennella,** Heyd.)

Hemiteles areator, Panz. I. 2 : 134.

Coleophora ardeaepennella, Scott

Hemiteles areator, Panz. I. 2 : 134.
Pimpla calobata, Grav. I. 3 : 83.

Coleophora currucipennella, Zell.

Hemiteles areator, Panz. I. 2 : 133.
Pimpla alternans, Grav. I. 3 : 106.

Coleophora niveicostella, Zell.

Orgilus obscurator, Nees. B. 1 : 596.

Coleophora discordella, Zell.

Angitia elishae, Brdg. I. 5 : 184.
,, *insectator,* Schr. Beer, Devon, bred by K. G. Blair.
Orgilus obscurator, Nees. B. 1 : 596.
? *Agathis anglica,* Marsh. B. 1 : 566.

Coleophora genistae, St.

Pezomachus instabilis, Fst. I. 2 : 228.
Angitia annulicrus, Thoms. I. 5 : 180.

Coleophora saturatella, St.

Pezomachus impotens, Fst. I. 2 : 213.

Coleophora onosmella, Brahm.

Omorga ensator, Grav. I. 5 : 154.

Coleophora nutanella, Mühl. (**inflatae,** St.)

Pimpla punctiventris, Thoms. I. 3 : 76.

Coleophora therinella, Tengst.

Hemiteles areator, Panz. I. 2 : 133.
Sagaritis zonata, Grav. I. 5 : 100.
Omorga multicincta, Grav. I. 5 : 156.

Coleophora troglodytella, Dup.

Omorga borealis, Zett. I. 5 : 150.
Earinus variicoxis, Wesm. B. 1 : 592.
Agathis brevisetis, Nees. B. 3 : 191.

Coleophora lineolea, Haw.

Angitia tibialis, Grav. I. 5 : 198.

Coleophora murinipennella, Dup.

Apanteles fuliginosus, Wesm. B. 1 : 469.

Coleophora caespititiella, Zell.

Hemiteles (*Aschistus*) sp. I. 2 : 109.
Pezomachus instabilis, Fst. I. 2 : 228.
Bracon osculator, Nees. B. 1 : 158.

Coleophora salinella, St.

Apanteles ononidis, Marsh. B. 1 : 461.

Coleophora virgaureae, St.

Bracon osculator, Nees. B. 3 : 85.

Coleophora hemerobiella, Scop.

Hemiteles similis, Gmel. I. 2 : 150.

Coleophora laricella, Hb.

Omorga tumidula, Grav. I. 5 : 155.
Bracon guttiger, Wesm. B. 1 : 129.
Microdus pumilus, Ratz. B. 1 : 582.

Coleophora albitarsella, Zell.

Angitia annulicrus, Thoms. I. 5 : 180.
,, *tibialis,* Grav. I. 5 : 198.
? *Agathis anglica,* Marsh. B. 1 : 566.

Coleophora nigricella, Steph.

Hemiteles areator, Panz. I. 2 : 133.
,, *cingulator,* Grav. I. 2 : 135.
Apanteles fuliginosus, Wesm. B. 1 : 469.
? *Opius rufipes,* Wesm. B. 2 : 337.

Coleophora fuscedinella, Zell.

Hemiteles areator, Panz. I. 2 : 133.
Pezomachus palpator, Grav. I. 2 : 236.
Omorga tumidula, Grav. I. 5 : 155.

Coleophora gryphipennella, Bch.

Angitia tibialis, Grav. I. 5 : 198.
Ascogaster rufipes, Nees. B. 1 : 358.
Microdus rufipes, Nees. B. 1 : 587.

Coleophora viminetella, Zell.

Hemiteles areator, Panz. I. 2 : 133.
Pezomachus corruptor, Fst. I. 2 : 225.

Coleophora solitariella, Zell.

Microcryptus labralis, Grav. I. 2 : 53.
Cremastus sp. I. 5 : 55.
Omorga tumidula, Grav. I. 5 : 155.

ELACHISTIDAE.

Bedellia somnulentella, Zell.

Angitia elishae, Brdg. I. 5 : 184.

Cosmopteryx lienigiella, Zell.

Chelonus exilis, Marsh. B. 1 : 340.

Epermenia (Chauliodus) chaerophyllella, Goeze

Apanteles infimus, Hal. B. 1 : 462.

Mompha (Laverna) miscella, Schiff.

Orgilus obscurator, Nees. B. 1 : 596.

Mompha raschkiella, Zell.

Colastes braconius, Hal. Box Hill, bred by K. G. Blair.

Mompha conturbatella, Hb.

Pimpla ventricosa, Tschek. I. 3 : 91.
Phytodiaetus obscurus, Desv. I. 3 : 247.
Nepiesta aberrans, Grav. I. 5 : 129.
Angitia nana, Grav. I. 5 : 183.
,, *cylindrica,* Brisch. I. 5 : 196.
,, *interrupta,* Hlmgr. I. 5 : 202.
Meteorus ictericus, Nees. B. 2 : 80.

Mompha fulvescens, Haw. (**epilobiella,** Schr.)

Hemiteles incisus, Brdg. I. 2 : 143.
,, *laevigatus,* Ratz. I. 2 : 153.
Pezomachus instabilis, Fst. I. 2 : 228.
Pimpla punctiventris, Thoms. I. 3 : 76.
,, *nucum,* Ratz. I. 3 : 84.
,, *maculator,* Fab. I. 4 : 105.
Pectenella latungula, Thoms. I. 5:174 *bis.*
Angitia nana, Grav. I. 5 : 183.
,, *rufipes,* Grav. I. 5 : 189.
,, *cerophaga,* Grav. I. 5 : 195.

Mompha decorella, Steph.

Hemiteles laevigatus, Ratz. I. 2 : 153.

Mompha (Chrysoclysta) schrankella, Hb.

Hemiteles laevigatus, Ratz. I. 2 : 153.

Chrysoclysta linneella, Clerck

Ascogaster annularis, Nees. Chiswick, bred by J. Waterston.

Heliodines roesella, Linn.

Hemiteles aestivalis, Grav. I. 2 : 166.
? *Promethus festivus,* Fab. I. 4 : 123.
Opius nitidulator, Nees. B. 3 : 236.

Stephensia brunnichella, Linn.

Phaeogenes argutus, Wesm. I. 1 : 246.

Elachista gleichenella, Fab.

Apanteles umbellatarum, Hal. B. 1 : 484.

Elachista magnificella, Tgstr.

Apanteles viminetorum, Wesm. B. 1 : 458.

Elachista atricomella, St.

? *Chelonus pusio,* Marsh. B. 1 : 347.

Elachista luticomella, Zell.

? *Chelonus pusio,* Marsh. B. 1 : 347.

Elachista alpinella, St. (**monticola,** Wk.)

Limnerium monticolanum, Brdg. I. 5 : 120.

Elachista subnigrella, Doug.

Pezomachus anthracinus, Fst. I. 2 : 208.

Elachista perplexella, St.

Apanteles viminetorum, Wesm. B. 1 : 458.

Elachista taeniatella, St.

Apanteles bicolor, Nees. B. 1 : 480.
,, *lateralis*, Hal. B. 1 : 488.

Elachista cerusella, Hb.

Angitia ruficornis, Brdg. I. 5 : 182.
Sagaritis erythropus, Thoms. Bromley, bred by S. Jacobs.

Tischeria complanella, Hb.

Pimpla brevicornis, Grav. I. 3 : 74.
,, *sagax*, Htg. I. 3 : 81.
Omorga borealis, Zett. I. 5 : 150.
Apanteles bicolor, Nees. B. 1 : 480.

Tischeria dodonaea, Heyd.

Colastes braconius, Hal. B. 1 : 188.

Tischeria marginea, Haw.

Ophion sp. I. 5 : cf. p. 359.

Tischeria angusticollella, Dup.

Thersilochus saltator, Fab. I. 5 : 54.

LITHOCOLLETIDAE.

Lithocolletis hortella, Fab.

Pimpla alternans, Grav. I. 3 : 106.

Lithocolletis amyotella, Dup.

Apanteles nanus, Reinh. B. 1 : 456.

Lithocolletis lantanella, Schr.

Colastes braconius, Hal. B. 1 : 188.
Apanteles nanus, Reinh. B. 1 : 456.
,, *bicolor*, Nees. B. 1 : 480.
,, *lautellus*, Marsh. B. 1: 483.

Lithocolletis nigrescentella, Logan (**bremiella,** Frey)

Hemiteles submarginatus, Brdg. I. 2 : 126.
Colastes braconius, Hal. B. 1 : 188.

Lithocolletis lautella, Zell.

Colastes braconius, Hal. B. 1 : 188.
Apanteles lautellus, Marsh. B. 1 : 483.

Lithocolletis vacciniella, St. (**junoniella,** Zell.)

Apanteles bicolor, Nees. B. 1 : 480.
,, *contaminatus*, Hal. B. 3 : 178.

Lithocolletis schreberella, Fab. (**cavella,** Zell.)

Hemiteles submarginatus, Brdg. I. 2 : 126.
Pimpla maculator, Fab. I. 3 : 105.
Colastes braconius, Hal. B. 1 : 188.
Acoelius subfasciatus, Hal. B. 1 : 399.
Apanteles bicolor, Nees. B. 1 : 480.
,, *lautellus*, Marsh. B. 1 : 483.

Lithocolletis blanchardella, Fab. (**pomifoliella,** Zell.)

Apanteles bicolor, Nees. B. 1 : 480.
,, *blanchardellae*, Bch. B. 1 : 490.
,, *flavolimbatus*, Ratz. B. 1: 493.

Lithocolletis spinicolella, Zell.

Hemiteles similis, Gmel. I. 2 : 150.
Apanteles bicolor, Nees. B. 1 : 480.
,, *umbellatarum*, Hal. B. 1 : 484.

Lithocolletis mespilella, Hb. (**torminella,** Frey)

Bracon variegator, Nees. B. 1 : 100.

Lithocolletis ulmifoliella, Hb.

Angitia exareolata, Ratz. I. 5 : 203.

Lithocolletis quercifoliella, Zell.

Colastes braconius, Hal. B. 1 : 188.

Lithocolletis corylifoliella, Haw.

Pimpla sagax, Htg. I. 3 : 81.

Lithocolletis alnifoliella, Dup.

Acoelius subfasciatus, Hal. B. 1 : 400.

Lithocolletis cramerella, Fab.

Colastes braconius, Hal. B. 1 : 188.

Lithocolletis tenella, Zell.

Colastes braconius, Hal. B. 1 : 188.

Lithocolletis sylvella, Haw.

Pimpla maculator, Fab. I. 3 : 105.

Lithocolletis frölichiella, Zell.

Hemiteles conformis, Gmel. I. 2 : 129.

Lithocolletis kleemannella, Fab.

Encyrtid, Bromley, bred by S. Jacobs.

Lithocolletis tristrigella, Haw.

Colastes braconius, Hal. B. 1 : 188.

Lithocolletis trifasciella, Haw.

Pimpla sagax, Htg. I. 3 : 81.

LYONETIIDAE.

Lyonetia clerckella, Linn.
Apanteles fuliginosus, Wesm. B. 1: 469.

Leucoptera (Cemiostoma) scitella, Zell.
Apanteles albipennis, Nees. B. 3 : 179.

Leucoptera lotella, St.
Caenocryptus rufiventris, Grav. I. 2: 322.

Bucculatrix cidarella, Zell.
Angitia annulipes, Brdg. I. 5 : 184.
,, *crassa,* Brdg. I. 5 : 186.

NEPTICULIDAE.

Nepticula basiguttella, Hein.
Acoelius subfasciatus, Hal. B. 1 : 399.

Nepticula anomalella, Goeze
Acoelius subfasciatus, Hal. B. 1 : 399.

Nepticula aucupariae, Frey
Angitia ? elishae, Brdg. I. 5 : 184.
Colastes braconius, Hal. B. 1 : 188.
Acoelius subfasciatus, Hal. B. 1 : 399.

Nepticula septembrella, St.
Mirax spartii, Hal. B. 1 : 392.

Nepticula weaveri, St.
Acoelius subfasciatus, Hal. B. 1 : 399.

Nepticula argyropeza, Zell.
Acoelius subfasciatus, Hal. B. 1 : 399.

Nepticula trimaculella, Haw.
Acoelius subfasciatus, Hal. B. 1 : 399.

Nepticula salicis, St.
Acoelius subfasciatus, Hal. B. 1 : 399.

Nepticula poterii, St.
Acoelius subfasciatus, Hal. B. 1 : 399.

Nepticula betulicola, St.
Mirax spartii, Hal. B. 3 : 175.

Nepticula plagicolella, St.
Acoelius subfasciatus, Hal. B. 1 : 399.

Nepticula marginicolella, St.
Acoelius subfasciatus, Hal. B. 1 : 399.

Nepticula centifoliella, Zell.
Pezomachus sp. I. 2 : 179.

ON THE INTERNAL ANATOMY OF SOME THYSANOPTERA

By U. S. Sharga, M.Sc., Ph.D.

[Read 5th April, 1933.]

With Plates X to XIX.

Contents.

		PAGE
1.	Introduction	185
2.	Digestive System	186
3.	Glandular System	189
4.	Excretory System and Fat-body	193
5.	Nervous System	194
6.	Reproductive System	196
7.	References	201
8.	Lettering and Explanation of Plates	202

1. Introduction.

Although our knowledge of the systematics and biology of Thysanoptera has been recently considerably advanced, their internal anatomy has been very little studied. This is partly due to the minute size of the insects.

Most of what is known is due to the pioneer work of Jordan (1888), Uzel (1895) and Buffa (1898). Later on Cary (1902) made a study of the internal anatomy of *Anaphothrips striata*, Osborn. In 1915, Peterson studied the salivary and head glands in *Heliothrips femoralis* and *Cephalothrips yuccae*. In 1926, Klocke published a paper on the anatomy and histology of Thysanoptera. Recently Radulesco (1931) has made a cytological study of several species of thrips. But none of the above writers has given a clear comparative description of the different internal parts.

In the present paper the internal anatomy of thrips has been described after dissecting several species. Ten common species were taken for dissection purposes, *viz.* :—

Aeolothripidae :— *Melanthrips fuscus*, Sulzer.
Thripidae :— *Aptinothrips rufus*, Gmelin; *Odontothrips ulicis*, Haliday; *Limothrips cerealium*, Haliday; *Heliothrips haemorrhoidalis*, Bouché; *Taeniothrips vulgatissimus*, Haliday; *Taeniothrips atratus*, Haliday; *Thrips tabaci*, Lindeman; *Kakothrips robustus*, Uzel.
Phloeothripidae :—*Haplothrips distinguendus*, Uzel.

The digestive system presents certain peculiarities, and in order to homologise the parts in the three families of thrips with the typical digestive system of other insects, certain new nomenclature has been introduced where considered necessary. So far only four rectal glands have been known to occur in thrips, and I have found four in most species, though in *Melanthrips fuscus*, Sulzer, five rectal glands were found for the first time in Thysanoptera. The salivary

glands also differ in number, form, and attachment, and in the course of the anterior ducts.

The female reproductive organs are more uniform except the difference in the shape of the receptaculum seminis; but the male reproductive organs sometimes show great dissimilarity. In *Odontothrips ulicis*, Haliday, a third kind of unpaired gland is found and in *Taeniothrips atratus*, Haliday, the two testes are connected by a commissure.

The work was done in the Department of Agricultural Zoology, University of Edinburgh, under the supervision of Dr. C. B. Williams. I am greatly indebted to him for valuable suggestions and advice and for placing at my disposal all his collections and literature on Thysanoptera, without which the present paper could not have been written. I am also grateful to Dr. G. D. Morison for the identification of a few species of thrips.

Technique.

Dissection was carried out with a pair of fine needles under a Leitz binocular microscope (× 75; × 150) with the insect alive in a drop of physiological salt solution. For dissecting the alimentary canal, the head capsule was opened first, and then the last abdominal segments were separated from the rectum; after this the whole alimentary canal was drawn out from the front side. The reproductive system was dissected similarly from the dorsal side. Dissection of the glandular system, and ducts, nervous system and other parts, necessitated the breaking away of the chitin gradually and carefully in small pieces.

In all cases one system should be dissected in one specimen, and in no case should the thrips be killed in any fixing fluid before dissection. Preserved or fixed specimens are useless as the internal parts become coagulated and tend to remain inside the body, making dissection much more difficult.

The internal structures were fixed in Bouin's fluid and then washed in water and subsequently in weak alcoholic solutions to remove picric acid. Corrosive sublimate and Carnoy's fluid also proved good fixing reagents. The stain used was haematoxylin and eosin. Carmalum and methyl green also gave good results with the glandular tissues and the enteric epithelium of the mid-intestine.

2. Digestive System.

The digestive system consists of a tubular alimentary canal, and in all thrips is divisible on a structural basis into three parts: the fore-intestine, the mid-intestine and the hind-intestine. The surface and histological structures of fore- and hind-intestine are similar, but different from the mid-intestine. The fore- and hind-intestine are lined with chitin.

The alimentary canal in *Aptinothrips rufus* (pl. X, fig. 1) is about twice as long as the insect, and consequently lies in a convoluted form in the body cavity. It measures about 2·3 mm. in length.

The fore-intestine (pl. X, fig. 1) is a small, very short, thin, tubular part, about one-eighth the length of the whole intestine. It consists of a chitinous pharynx, an oesophagus and a short crop. Long muscular fibres are situated in its walls, having small nuclei scattered at long intervals. Clear and distinct cell walls are not visible.

The pharynx is a short dark brown highly chitinised vestibular structure lying under the membranous clypeus and chitinised labrum. There are also certain muscles attached to it which help suction.

The sucking pharynx leads into the oesophagus at its hind part, and this

is a short delicate thin-walled tube of even calibre about one and three-fifths of the length of the fore-intestine, measuring about ·16 mm. in length and 13·3 μ in width (pl. X, fig. 1).

The oesophagus slightly dilates posteriorly where it joins with the mid-intestine. This part I have called the crop, since it is homologous with the crop in other insects. The crop is about three times as wide as the oesophagus, and in fresh dissections it is visible as a clear white hinder part of that organ. Jordan (1888) in *Heliothrips dracaenae*, Heeg, called the whole tube behind the pharynx to the beginning of the mid-intestine, oesophagus (Schlund); and Buffa (1898) in *Heliothrips haemorrhoidalis*, Bouché, called the hind part, the cardias; while Uzel (1895) called the hind part, a dilatation of the oesophagus (Erweiterungen des oesophagus). This part I have called crop, since in other species of thrips it is much widened and is decidedly homologous with the crop in other insects. The crop measures about ·1 mm. in length and ·0366 mm. in width.

The mid-intestine (pl. X, fig. 1) is the longest part of the alimentary canal and lies in a convoluted form in the body cavity. It is about six times as long as the fore-intestine and three times as long as the hind-intestine. Anteriorly it is dilated to form a cylindrical wide tube where it joins with the crop. This front portion of the mid-intestine (pl. X, fig. 1) is about three times as wide as the crop and is like a cylindrical tube, which is about one-third of the length of the mid-intestine. It is ·528 mm. long and ·1 mm. wide. Further back it narrows into a long narrow tube, which again dilates posteriorly where it joins with the hind-intestine. The middle portion is about 42 μ in width at its front end and widens slowly to 71 μ and finally to 85 μ where it joins with the hind-intestine. At the junction of the mid- and hind-intestine are situated four malpighian tubes (pl. X, fig. 2).

The structure of the mid-intestine is altogether different from the fore- and hind-intestine, as is easily seen in stained preparations under high magnifications even without sectioning. The walls of the mid-intestine are composed of enteric epithelium which consist of large, clearly demarcated, polyhedral cells paved all through (pl. XVI, fig. 7). The cells are flat and contain one, or apparently more than one, nucleus, and these are very large and prominent. Some of these cells are very large while others are smaller. Some measure 36–41 μ in length and 28 μ in width with two or more nuclei, each 13 μ across. The chromatin granules and other parts of the cells are also clearly seen within the nuclei and the cell walls.

The hind-intestine in *Aptinothrips rufus* (pl. X, fig. 2) is shorter than the mid-intestine, and its beginning is marked by the insertion of malpighian tubes. It is about twice as long as the fore-intestine and one-third as long as the mid-intestine. The hind-intestine is not a tube of even calibre but is dilated at certain places (pl. X, fig. 2). Jordan (1888) and Cary (1902) did not homologise the parts of the hind-intestine in *Heliothrips dracaenae* and *Anaphothrips striata*. Uzel (1895) in *Aeolothrips fasciatus* divided the hind-intestine into small intestine and large posterior intestine. Buffa (1898) divided the hind-intestine in *Heliothrips haemorrhoidalis* on the basis of rectal glands into :—1. Pre-glandular part. 2. Glandular part. 3. Post-glandular part. And his division has been accepted and applied by Klocke (1926) in *Thrips physopus*. I find that this classification does not lie sufficiently on a homologous structural basis to justify its application to *A. rufus* and other species. I therefore propose to divide the hind-intestine into ilium and rectum, on the basis of the presence of a definite constriction separating one from the other.

The pre-glandular part of Buffa (1898) will thus become the ilium. The rectum, however, may, for the sake of convenience, be further divided into a glandular and post-glandular part as done by Buffa (1898).

The ilium is a short tubular structure wider anteriorly at the junction of the malpighian tubes and separated forwards from the mid-intestine histologically, and posteriorly from the rectum by a slight constriction. Klocke (1926) has also shown that there are definite ring muscles between the ilium (pre-glandular part) and rectum (glandular part). The ilium measures about 123 μ long and 70 μ wide at the top and 33 μ in the middle. The colon is treated here as absent or undifferentiated from the ilium.

The rectum (pl. X, fig. 2) is a wide pyriform structure, distinct and swollen in fed and unpricked specimens, and rather shrunken otherwise. It is about 28 μ in length and 100 μ in breadth. The bladder-shaped rectum carries four oval rectal glands which are well separated from one another in the walls of the rectum. Each rectal gland is about 50 μ in length and 38 μ in width. The glands, when stained, appear to contain very large nuclei, each about 20 μ across. The hinder part of the rectum which does not possess any glands is a tube of almost even calibre, opening finally to the exterior through the anus.

The alimentary canal in *Aptinothrips* larvae is proportionally shorter, but is of the same form, parts and structures, as in the imagines. There are four rectal glands present in the first stage larvae (pl. X, fig. 3) and similarly in the second stage, as in the imagines.

The digestive system is similar in *Limothrips cerealium*, Hal.; *Odontothrips ulicis*, Hal.; *Taeniothrips atratus*, Hal.; *Taeniothrips vulgatissimus*, Hal.; *Thrips tabaci*, Lind.; and *Kakothrips robustus*, Uzel. In *Heliothrips haemorrhoidalis*, Bch., the alimentary canal (pl. X, fig. 4) is as described and figured by Buffa (1898), and differs from *A. rufus* and other species, in that the mid-intestine after the constriction of the cylindrical front portion, instead of narrowing as in *A. rufus*, widens out considerably and proceeds backwards for a short distance and then narrows as shown in the figure. The rest of the mid- and hind-intestine (pl. X, figs. 4–5) is similar to that of *A. rufus*. The mid-intestine is similarly paved with enteric epithelium as in *A. rufus*.

In *Melanthrips fuscus*, Sulz. (Aeolothripidae), the fore-intestine is a very large, long, and wide structure (pl. XI, figs. 1, 3). The mouth leads into a sucking pharynx which leads into a tubular thin oesophagus. The oesophagus widens out considerably at the posterior end into a long wide chamber, the crop. The wide posterior chamber of the fore-intestine in this species gives the true shape of the crop in other insects. In *A. rufus* and other species the crop on the contrary is attenuated.

The mid-intestine is a long wide structure as in *A. rufus*. The front portion of the mid-intestine (pl. XI, fig. 1) instead of being tubular as in *A. rufus*, is a much wider, spindle-shaped and shorter structure, narrowing posteriorly into a thin tube and widening again slightly before joining with the hind-gut. Occasionally specimens were found, in which the front portion of the mid-intestine was slightly constricted in the middle (pl. XI, fig. 3); but these may be considered abnormal. The walls of the mid-intestine are composed of clearly demarcated, polyhedral enteric epithelium (pl. XIII, fig. 7) as in *A. rufus*.

The hind-intestine of *M. fuscus* consists of a short ilium which is broader anteriorly and tubular posteriorly (pl. XI, fig. 2), separated from the rectum by a short, well-defined constriction as in *A. rufus*. The rectum is long and wide at the anterior glandular part or slightly shrunken when pricked, and

it is tubular and thin posteriorly. There are five rectal glands situated in the anterior part of the rectal wall and widely separated. The presence of five rectal glands in thrips has not been previously noted. The post-glandular part of the rectum is short (pl. XI, figs. 1–3).

In *Haplothrips distinguendus*, Uzel (Phloeothripidae, Tubulifera), the alimentary canal is a shorter and much wider structure (pl. XI, fig. 3) unlike that of *A. rufus* and other species of Terebrantia. The mouth leads into a vestibular pharynx which leads into a thin tubular oesophagus. The oesophagus opens posteriorly into a crop which is wider than in *A. rufus* and other species; but shorter than in *Melanthrips fuscus* (Aeolothripidae). The crop opens posteriorly into a wide mid-intestine (pl. XI, fig. 3).

The mid-intestine is a shorter but very much wider structure than in Terebrantia. The front portion is long and cylindrical and very much wider than in other species examined. Posteriorly, instead of narrowing as in *A. rufus* or other Thripidae or in *Melanthrips fuscus*, it opens into a wide globular chamber. This chamber gradually narrows down into a thin short tube which dilates considerably posteriorly before opening into the hind-gut. The entire structure of the mid-intestine is composed of clearly defined enteric epithelium with prominent nuclei, as in other species. The hind-gut of *H. distinguendus* (pl. XI, fig. 5) consists anteriorly of a short ampulla-shaped ilium, which is separated from the rectum by a well-defined sharp constriction. The rectum is pyriform, very wide at the anterior glandular part, becoming tubular and thin at the posterior, post-glandular part. There are four oval rectal glands in the globular wall of the anterior part of rectum. The post-glandular part is thin and tubular. The general outline of the alimentary canal in this species resembles that of *Trichothrips copiosa* as described by Uzel (1895) and *Phloeothrips brunnea* as described by Jordan (1888).

3. Glandular System.

A review of the previous work on salivary glands in thrips shows that there has been considerable difference of opinion regarding the number of salivary glands and the course of their ducts in various species in the two sub-orders of Thysanoptera. Below is summarised, according to their nearest homologies, the number of salivary glands as found by Jordan (1888), Uzel (1895), Buffa (1898), Cary (1902), Peterson (1915), Klocke (1926) and myself, in various species, and these are arranged according to the three families of Thysanoptera.

It will be seen from the table below that in *Aeolothrips fasciatus* Uzel (1895) described two pairs of salivary glands, one pair short and thick and the other pair long and tubular. He did not trace the anterior course of ducts, and his short glands are separate posteriorly. In *Melanthrips fuscus* I have found only two pairs of salivary glands. The first is very much smaller, more or less cylindroid with a thin anterior duct, similar to the short, paired, salivary glands of *A. rufus* and other species (pl. XIII, fig. 1). The second pair of salivary glands is thin and tubular (pl. XI, fig. 6), similar in structure to that of other species and arising similarly from the sides of the hind part of the front portion of the mid-intestine (pl. XI, figs. 1, 3). These two short and tubular salivary glands are therefore homologous with the short and tubular glands of various species of thrips.

In *Heliothrips dracaenae* Jordan (1888) described two pairs of salivary glands, one pair short with large cells and nuclei, and the other tubular and long. He showed the short pairs as separate and did not trace the anterior

	First pair.	Second pair (short and thick).	Third pair (long and tubular).	Head gland.
I. Aeolothripidae :—				
Aeolothrips fasciata (Uzel, 1895) .	—	1	1	—
Melanthrips fuscus (Sharga). .	—	1	1	—
II. Thripidae :—				
Anaphothrips striata (Cary, 1902)	—	1	—	—
Heliothrips dracaenae (Jordan, 1888)	—	1	1	—
H. haemorrhoidalis (Buffa, 1898) .	1	1	1	—
H. femoralis (Peterson, 1915) .	—	1	1	1
Thrips physopus (Klocke, 1926) .	1	1	1	—
Aptinothrips rufus (Sharga) .	—	1	1	—
Limothrips cerealium (Sharga) .	—	1	1	—
Odontothrips ulicis (Sharga). .	—	1	1	—
Taeniothrips vulgatissimus (Sharga)	—	1	1	—
T. atratus (Sharga) . . .	—	1	1	—
Thrips tabaci (Sharga) . .	—	1	1	—
Kakothrips robustus (Sharga) .	—	1	1	—
Heliothrips haemorrhoidalis (Sharga)	1 (unpaired)	1	1	—
III. Phloeothripidae :—				
Phloeothrips brunnea (Jordan, 1888)	—	1	1	—
Trichothrips copiosa (Uzel, 1895) .	1	1	1	—
Cephalothrips yuccae (Peterson, 1915)	—	1	1	—
Haplothrips distinguendus (Sharga)	—	1	1	—

course of ducts. Buffa (1898) in *H. haemorrhoidalis* found three kinds of paired salivary glands. According to him, the first pair is the smallest, having large cells and nuclei. The second pair is globular or spherical with larger cells and nuclei. Proximally each ends in a thin duct, and distally each gland is separate and is joined with the terminal filament from each group of ovarian tubes. The third pair is long and tubular. He likewise did not trace the course of anterior ducts. Buffa (1898) on the other hand found one pair of extra salivary glands besides those two pairs already mentioned by Jordan (1888) in *H. dracaenae*, and by Uzel (1895) in *Aeolothrips fasciatus*. Cary (1902) described and figured only one pair of salivary glands (short and thick) separate posteriorly in *Anaphothrips striatus*. Peterson (1915) in *Heliothrips femoralis* found only two pairs of salivary glands, one short and one long, homologous with the first (short and thick) and second (long and tubular) pairs of Jordan (*H. dracaenae*, 1888) and Uzel (*A. fasciatus*, 1895), and the second (short and thick) and third (long and tubular) pairs of Buffa (*H. haemorrhoidalis*, 1895) and the only pair (short and thick) described by Cary (1902). Moreover his two short thick salivary glands are separate posteriorly in *H. femoralis*, and anteriorly the ducts go straight to the common duct. In addition to these glands, he mentions a third type of gland which he designates as the *head gland*, which differs in histological structure from the thoracic glands. Recently Klocke (1926) described three pairs of salivary glands in some Thysanoptera. Most of his work was done on *Thrips physopus*, but he does not exactly mention the species in which he found the first pair. According to him the first pair of salivary glands is pear-shaped, extraordinarily small, and lies dorsal to the alimentary canal, bending downwards between the brain and the sub-

oesophageal ganglion. He was not able to find the openings of these glands. The other two pairs are similar and homologous with the short and thick, and long and thin salivary glands.

In *Aptinothrips rufus* there are two pairs of salivary glands, one being short and thick, and the other long and tubular (pl. XII, fig. 1).

The first pair, more or less oval (pl. XII, fig. 2), is situated in the metathorax and the first abdominal segment and lies either dorsally or laterally. The two glands which normally lie on each side are not separate, but are joined at the posterior end by a small fine connective tissue (pl. XII, fig. 2). If not carefully manipulated, the connection breaks during dissection, and the two small glands appear as unconnected organs on either side of the alimentary canal (pl. XII, fig. 1). Two very short ducts which lie embedded in the central glandular tissue arise at the anterior ends of the short glands (pl. XII, figs. 1–2). These ducts pass forwards and after joining with the sides of the "*widened parts*" or the reservoirs of the second long salivary glands, proceed forwards. The ducts are of uniform diameter throughout. The connection of the ducts with the sides of the reservoir is so intimate and close, that I have not been able to separate the ducts without breaking them. Apparently the ducts do not open in the reservoir, as they continue their course forwards, as separate and distinct structures, and are separate from the ducts of the other pair of salivary glands. The duct from the right short gland unites with the duct of the left salivary gland much anteriorly and forms the common duct which opens into the common duct of the other pair of long and tubular salivary glands, thus forming the main duct of the salivary glands, which opens more anteriorly into the oesophagus (pl. XII, fig. 1).

The cells of these glands are very large and distinctly differentiated, and sometimes their nuclei are even visible in unstained preparations. One or two deeply staining nuclei are present in each cell and various stages of nuclear division can sometimes be seen. The gland is about 134 μ long and 61 μ broad; while one of the component cells is 71 μ long and 33 μ wide, and the contained nuclei about 16 μ across. In fresh dissections, they appear as clear translucent structures.

The second pair of salivary glands is a long, narrow, clear, thin-walled tube, situated laterally to the alimentary canal and extending to a much greater length in the abdomen than the first pair (pl. XII, fig. 1). In some this pair of glands is a very narrow structure, while in others, it is slightly broader. Posteriorly the glands originate as tubes on each side of the cylindrical hind part of the front portion of the mid-intestine. They extend anteriorly, more or less, as homogeneous tubes except near the sides of the oesophagus where the ducts widen out to form reservoirs to which are attached the ducts of the short salivary glands already mentioned. The enlarged portion of the lumen probably functions as a storage chamber. Anteriorly the right and left ducts unite to form a common duct of the short salivary glands as already described.

The cells of these glands are very long with very fine central winding lumen (pl. XII, fig. 3). The nuclei are short, scattered at long distances. Distinct cell walls are not seen, thus giving the appearance of a syncytium. The tubular glands are about 6 μ wide with the nuclei about 3 μ across.

In *Limothrips cerealium*, the short pair of salivary glands (pl. XII, fig. 4) is much longer and thinner than in *A. rufus*. It is two cells thick with a well-differentiated cell wall. Each cell contains usually two nuclei, but one only may be present. Anteriorly there is a thin duct arising from each, and pos-

teriorly the glands are joined together by a short connective tissue as in *A. rufus*. The other pair of glands is tubular and is similar to *A. rufus* in structure and place of origin.

In *Odontothrips ulicis*, the short salivary glands are long and thin, having a duct anteriorly in each gland, and joined posteriorly by a connective tissue (pl. XII, fig. 5) as in *A. rufus* and *L. cerealium*.

Two more or less similar pairs of short and thick, long and tubular salivary glands are present in *Taeniothrips vulgatissimus* and *T. atratus*, Hal.; *Thrips tabaci*, Lind.; *Kakothrips robustus*, Uzel, and *H. haemorrhoidalis*, Bch. These two pairs of salivary glands are homologous with the first (short and thick) and second (long and tubular) pairs of glands of Jordan (*H. dracaenae*, 1888), Uzel (*A. fasciatus*, 1895) and Peterson (*H. femoralis*, 1915); and with the second (short and thick) and third (long and tubular) pairs of glands found by Buffa (*H. haemorrhoidalis*, 1898), and Klocke (*Thrips physopus*, etc. 1926). I have not been able to find the head gland of Peterson (1915) or the very small pear-shaped gland found by Klocke (1926) in *A. rufus* and other species. Further it is important to note that the short salivary glands in *A. rufus*, *O. ulicis* and *L. cerealium* are joined posteriorly, and that in *A. rufus* their anterior ducts meet the reservoirs, before proceeding forwards, to form the common duct as discussed previously.

In *Heliothrips haemorrhoidalis*, three kinds of salivary glands are found. The first gland is unpaired. It is thin and small, wider posteriorly, gradually becoming thinner anteriorly (pl. XIII, fig. 2). Inside, a few scattered nuclei may be seen, with a thin clear lumen. It is situated on the left side and appears to be associated with the left mandible. The second gland is paired, ovoid and thick (pl. XIII, fig. 3), similar to the short and thick pair in *A. rufus*, etc. Posteriorly, these short salivary glands are not joined with each other by any connective tissue, but are connected with the terminal filaments from each separate group of ovarian tubes in the female. Males of this species are not known. Each short gland has a duct anteriorly. The third gland is paired, tubular and long, arising from the hinder part of the front portion of the mid-intestine (pl. X, fig. 4), as in other species. This species is the same as that studied by Buffa (1898). As will appear from the description given above, I have found three kinds of glands, similar in structure and form as described by Buffa (1898). But the first gland has not been found paired as Buffa (1898) describes. In all my dissections, I have found a single, unpaired gland, on the left side, if the dissection is made dorsally, and on the right side if ventrally, appearing associated with the mandible. Buffa (1898) has figured it in his longitudinal section of thrips on the right side only, which position it will always take, if the sections are seen from the ventral side. The mandible in this case will be seen on the right side.

In the sub-order Tubulifera, Jordan (*Phloeothrips brunnea*, 1888) described two pairs of salivary glands, one short and thick and the other long and thin. In *Trichothrips copiosa* (PHLOEOTHRIPIDAE), Uzel has described three pairs of salivary glands, the first very small, the second short and thicker, and the third pair long and thinner. Peterson (1915) described a long and a short pair of glands in *Cephalothrips yuccae*, homologous with the two pairs of glands found by him in *H. femoralis*. In *Haplothrips distinguendus*, two pairs of salivary glands are present (pl. XIII, fig. 4), and unlike the previous species of Terebrantia, none of them is connected with the mid-intestine. The first pair is shorter and thicker than the second pair which is longer and tubular (pl. XIII, fig. 4). The first pair is thick, slightly constricted in the middle, and

connected posteriorly with the long salivary glands by a thread-like, fine, connective tissue. The cells are large, and the cell-walls are well differentiated, each with one or two prominent nuclei (pl. XIII, fig. 5). Anteriorly a thin duct is present. The second pair of salivary glands is longer and much thinner (pl. XIII, fig. 6). Posteriorly each is connected by a thin filament to the terminal part of each side of the ovary (pl. XIII, fig. 5). Several small nuclei are seen scattered inside the gland, and a clear lumen is also seen (pl. XIII, fig. 6). Anteriorly a fine duct is present. In *Trichothrips copiosa*, Uzel (1895) has shown that the short thicker pair is connected by a fine filament with the ovary. In *Haplothrips distinguendus* the connection is always with the long thin pair of salivary glands.

As regards the form of the first pair of short thick salivary glands in Terebrantia, they are bladder-shaped (Jordan, *H. dracaenae*, 1888), globular to thick spindle form (Priesner, *Aeolothrips*, 1928) or sac-shaped (Priesner, *Taeniothrips*, 1928). In *Aptinothrips*, they may be described as long oval. In other species of Terebrantia, some are long and thinner, while in others they are oval and thicker. In *Haplothrips distinguendus* (Tubulifera), the form of the first pair is quite unlike those shown by Jordan (1888) and Uzel (1895). All the previous workers agree as regards the long and tubular form of salivary glands in Terebrantia, and in *Aptinothrips rufus* and other species studied here, they are tubular and alike.

With regard to the position of the first pair of short salivary glands in the abdomen, they are situated according to Jordan (*H. dracaenae*, 1888) in the beginning of the abdomen or in the hind bursa, or after Buffa (*H. haemorrhoidalis*, 1898) in the mesothorax, or after Priesner (*T. vulgatissimus*, 1928) partly in the mesothorax and partly in the metathorax. In *Aptinothrips rufus*, I have found them partly in the metathorax and partly in the first abdominal segment.

In the larval stages of *Aptinothrips rufus*, I have found the same number of salivary glands situated as in the imagines. Priesner also (*Aeolothrips fasciatus* and *Taeniothrips ericae*, 1928) found only two pairs of salivary glands in the larval stages.

4. Excretory System and Fat-body.

The excretory products are principally discharged through the malpighian tubes, which are present in all Thysanoptera. Besides these, certain fat-bodies are also present.

Malpighian tubes :—

Jordan (1888) described four malpighian tubes in *H. dracaenae* and *Phloeothrips brunnea*. In *H. dracaenae*, he mentioned that the two anterior lobes lie contorted with each other and with the mid-gut. Uzel (1895) recorded the same number of malpighian tubes in *A. fasciatus* and *Trichothrips copiosa* ; but in *A. fasciatus*, he has described and shown that the two malpighian tubes of each side join to form a common canal which finally opens at the place of union of mid- and hind-gut. Buffa (1895) also described the same number of malpighian tubes in *H. haemorrhoidalis* and showed them lying by the sides of the mid- and hind-intestine, and a similar number was found by Cary (1902) in *Anaphothrips striata*.

In *Aptinothrips rufus*, there are four slender, moderately long, cylindrical malpighian tubes, a pair lying on each side of the alimentary canal and opening at the junction of the mid- and hind-gut (pl. X, figs. 1–2). They do not lie

free in the body cavity or intertwined with each other. Two anterior tubes, one on each side, run forwards, and two posterior ones run backwards, so as to be closely applied to the mid- and hind-gut. The malpighian tubes running posteriorly are more firmly applied to the sides of the hind-gut than the anterior ones. The anterior ones therefore become easily separated from their positions and appear to lie free in the body cavity, while the posterior pair remains applied. Each tube opens by a separate opening into the ilium.

In fresh dissections, the malpighian tubes appear brownish, and it has been observed that they contain some minute granules which are quickly thrown out in the ilium by a kind of rhythmic movement.

In stained preparations, the nuclei appear very large (8–11 μ across) and are clearly seen near the sides; while the central part is occupied by a long winding lumen (pl. XIV, fig. 1). Each tube measures about 457 μ in length; 16 μ wide at the base, 13 μ in the middle and 10 μ at the apex.

In *Aptinothrips* larvae, I have found the same number of malpighian tubes opening separately into the ilium, as in the imagines.

Four similar cylindrical malpighian tubes of various length are found in *L. cerealium*; *Odontothrips ulicis*; *Heliothrips haemorrhoidalis* (pl. X, figs. 4–5); *Taeniothrips atratus* and *T. vulgatissimus*; *Thrips tabaci*; *Kakothrips robustus*; *Melanthrips fuscus* (pl. XI, figs. 1–3); and *Haplothrips distinguendus* (pl. XI, figs. 4–5), opening separately at the junction of mid- and hind-gut. In *H. distinguendus* (Tubulifera), the malpighian tubes are rather longer, and deep brownish, opening very closely together between the mid-gut and the ampulla-like ilium (pl. XI, fig. 5).

Fat-body :—

The fat-body in *Aptinothrips rufus* lies primarily in the form of two long lobes (pl. XII, fig. 6) on either side of the body cavity; but secondarily may form several lobes packed round the various internal structures. It consists of large globular cells loosely connected together, which become easily broken into small groups of cells. They appear greenish in colour in fresh dissections. In stained preparations, they appear as a mass of vacuolated round cells (pl. XII, fig. 7). The nuclei are large and round and are present in some cells and completely absent from others. Fat-bodies are found both in larval and adult stages. Similar fat-bodies are found in *L. cerealium* (pl. XVI, fig. 6) and may also be present in other species of Thysanoptera.

5. Nervous System.

The nervous system in *Aptinothrips* is represented by a strongly developed brain and a greatly concentrated chain of large ganglia lying in the thorax and abdomen.

Brain :—

The brain is relatively large and can be easily differentiated from other ganglia by its position, form, and size. It lies in the head capsule and in *A. rufus* appears to consist of two flat broad lobes (pl. XIV, fig. 2). Each lobe is wider anteriorly and arched at the outer angles; and is narrower posteriorly. There is a short depression at the anterior middle part of the brain where two lobes seem to meet. On each side, the lobes slope down and make an inverted Y-shaped depression posteriorly at the place of union. Slightly below the anterior outer angles, each lobe has a very short thick optic nerve which bears

distally a globular optic ganglion (33 μ across). No definite suture across the vertical median line of the brain is seen, except the notch anteriorly and posteriorly already mentioned. The brain measures about 83 μ in length and 133 μ in greatest width. Behind the brain are a series of four large ganglia which according to their position can be named prothoracic, mesothoracic, metathoracic and abdominal ganglia.

Prothoracic ganglion :—

This is a moderately large and thick ganglion lying in the prothorax. Anteriorly it is joined with the brain, and posteriorly with the mesothoracic ganglion, by a strong and thick commissure.

Mesothoracic ganglion :—

This is the second thoracic ganglion situated in the mesothorax. It is almost as large as the prothoracic ganglion. Anteriorly it is joined by a very short thick commissure with the prothoracic ganglion; so that the pro- and meso-thoracic ganglia are very close together.

Metathoracic ganglion :—

This, the third large ganglion, is almost as broad as the two previously mentioned. It is connected by a thick commissure with the mesothoracic ganglion anteriorly and the first abdominal ganglion posteriorly. Posteriorly is attached a nerve on each side.

First abdominal ganglion :—

The first abdominal ganglion is a large spindle-formed structure somewhat widely separated from the metathoracic ganglion, and therefore the commissure joining the metathoracic and the first abdominal ganglia is clearly seen. It is longer than the thoracic ganglia and measures 90–116 μ in length and 50–66 μ in width. It is situated behind the pterothorax, probably occupying the first and second abdominal segments, but not in the metathorax. At the posterior end medially, it gives rise to the unpaired nerve chord. At each posterior side of the ganglion is attached a fairly thick nerve.

Nerve chord :—

The nerve chord is a median unpaired structure originating from the hinder part of the first abdominal ganglion and extending to the whole length of the body. It is slightly thicker anteriorly, and thinner posteriorly. At regular intervals, it gives rise to a pair of fine nerves in each segment. There are no visible thickenings or ganglia at the places where the segmental abdominal nerves originate. The first pair of abdominal nerves arises about 50 μ from the first abdominal ganglion and the second pair is about 86 μ from the first pair. The width of the nerve chord between the first and second pair of abdominal nerves is about 10 μ. Posteriorly it becomes still thinner.

Larval brain :—

In the larvae of *Aptinothrips rufus*, the brain is large in proportion to that found in the imagines. It consists of two long lobes united in the middle where a suture is distinctly seen (pl. XIV, fig. 3). It is rounded at the posterior end, and presents two very deep notches, one anteriorly and the other posteriorly. Anteriorly each lobe gives rise to a nerve the " Antennal-ocellaris nerve." This nerve and its branches supply the antennae and the eyes. The

most interesting thing noticed in the larvae is the situation of the brain. The larval brain has always been found in the prothorax or partly extending in the mesothorax. *The head capsule is entirely empty.* Each lobe measures about 133 μ in length and 50 μ in breadth. The brain of the larvae and the imagines with four ganglia contain a large number of small nuclei which stain deeply.

A similarly concentrated nervous system is found in the rest of the species of Thysanoptera examined. In *Limothrips cerealium*, the brain is long, wider anteriorly and with slight projections at the anterior angles showing the place of the optic nerves. Posteriorly there is a concentrated chain of three thoracic and one abdominal ganglia with a median nerve chord (pl. XIV, fig. 4). The commissure in this species is thick and clearly seen. In *Haplothrips distinguendus* (Tubulifera) the brain is much larger and of different shape. The optic nerves are situated at the anterior outer angles and are very short and thick with short thick optic ganglia. Posteriorly this species has also a similar chain of three thoracic and one abdominal ganglia with a median nerve chord (pl. XIV, fig. 5).

Jordan (1888), Uzel (1895), Buffa (1898) and Cary (1902) have figured the shape of the brain differently in the species they studied. Since the shape of the brain depends upon the form of the head capsule, there is bound to be some difference, as I have also found in different species examined. As regards the position of the abdominal ganglion, I have always found it behind the pterothorax, lying in the first and second abdominal segments.

6. Reproductive System.

(a) *Female.*

Externally the females of *Aptinothrips* (Thripidae) are distinguished by the presence of an ovipositor which is the most important external sexual character. It is attached to the eighth and ninth abdominal segments and is clearly visible through the body of the insect. It is composed of four valves, between which the eggs pass out, two of which form the under pair, and two the upper pair. The under pair is attached to the eighth segment and the upper pair to the ninth segment. The ovipositor lies curved downwards as in all Thripidae. Each pair of valves is widely separated basally and lies close together distally. Their anterior and posterior surfaces are provided with saw-like teeth.

The two valves of each pair on each side are fitted together so closely as to move forwards and backwards upon each other without being displaced. The upper or posterior valves are sabre-shaped, curved downwards and pointed at the end. The upper valve is provided with sharp, minute, numerous saw-like teeth, pointed basally, throughout the whole dorsal length, except a short distance from the base. Ventrally or on the lower edge of the upper plate is a ridge which fits in the groove of the dorsal part of the lower or anterior plate.

The lower or anterior valve is similarly curved and sabre-shaped, and as mentioned above, is provided with a groove at the dorsal part into which fits the ridge of the upper or posterior valve. The ventral or anterior side is indented with saw-like teeth for the greater part of its length. It carries sixteen sharp pointed teeth from tip to above the middle. Just inside are situated a second row of eight prominent teeth.

Internally in *Aptinothrips rufus*, the reproductive organs consist of an ovary

normally composed of eight ovarioles, lying in two groups, with four ovarioles in each, on either side of the hind-gut (pl. XIV, fig. 6). Occasionally a few individuals have been found to contain an abnormal ovary (pl. XV, fig. 1). These have nine ovarioles altogether, lying in groups of five and four ovarian tubes. The ovarioles do not lie free in the body cavity, but the terminal filaments from all ovarioles of one side or group, combine to form a single filament, and this combines with a similar one formed on the other side, to form a long median ligament. This ligament is finally joined with the posterior connective tissue of the short salivary glands.

Each ovariole is a long tube which holds the developing oocytes one behind the other in a single chain (pl. XIV, fig. 7). The oldest oocyte is situated near the base where the tube meets the oviduct. During the earlier stages of growth of the basal oocyte, the remaining upper part of the ovariole keeps the median position (pl. XIV, fig. 7). But when the oocyte has become very large and acquires the characteristic bean-shaped appearance of an egg, the upper part is tilted to one side on the top of the egg. In each ovarian tube, only the basal oocyte reaches maturity at any one time; but several eggs in different tubes may develop simultaneously. In no case has it been observed that two oocytes of the same ovarian tube may reach simultaneous maturity. It is only when the basal egg has been pushed out that another oocyte takes its place. The wall of an ovariole is a delicate transparent membrane and is capable of great enlargement during the maturation of an egg.

Three distinct regions can be distinguished in an ovariole. 1. Terminal filament. 2. Germarium. 3. Vitellarium.

1. *Terminal filament :—*

This is a long hair-like thread, and is the terminal prolongation of the outer wall of the ovarian tubes. The terminal filaments of all the ovarioles combine to form a ligament which is joined with the basal part of the short salivary glands. This maintains the ovary in position (pl. XIV, figs. 6–7).

2. *Germarium :—*

This is represented by the long conical part of the ovariole and consists of a mass of cells from which the primordial germ cells are differentiated (pl. XIV, figs. 7–8). The nuclei of the cells stain deeply. This portion contains a large number of small cells in various stages of development from above downwards, which later on give rise to young oocytes (pl. XIV, fig. 8). The nuclei of the small germ cells also stain deeply and are prominent. No nutritive cells have been recognised.

3. *Vitellarium :—*

This constitutes the longest part of the ovariole and contains the developing oocytes. The epithelial layer of the wall encloses each oocyte in a definite, clearly visible follicle. All the ovarioles are paniostic, as no vitellogenous cells are present either apically or in between the oocytes. All the ovarioles open by a short thin duct into a fairly wide, short, tubular oviduct. From two to four oocytes have been observed to lie in the vitellarium.

The oviducts are paired, short, tubular ducts which anteriorly receive the ducts of the ovarioles and posteriorly combine to form a common duct. Each oviduct measures about 33 μ in length and 36 μ in width. Posteriorly the common duct is continuous with a wider passage or vagina. The common duct anteriorly measures 66 μ and posteriorly (vagina) about 100 μ in width.

Associated with the vagina is the receptaculum seminis (spermatheca).

It is an oblong retort-shaped, flat structure, clear and shiny in fresh dissections (pl. XV, fig. 2). When stained, the walls contain prominent nuclei. The receptaculum seminis leads by a moderately long, wide canal, situated at an angle, as in a retort, and opens dorsally in the vagina. Colleterial or other accessory glands and a bursa copulatrix or their homologous parts have not been observed in any dissection. The receptaculum seminis measures 116 μ in length and 50 μ in width. The duct is about 25 μ wide with nuclei 3 μ across.

Similarly in other species of thrips, *Odontothrips ulicis*, *Taeniothrips atratus* and *vulgatissimus*, *Thrips tabaci*, *Heliothrips haemorrhoidalis*, *Limothrips cerealium*, *Kakothrips robustus*, *Melanthrips fuscus* and *Haplothrips distinguendus*, the ovary consists normally of eight ovarian tubes, divided in two groups of four, and lying on each side of the hind-gut. I have never found ovaries with five ovarian tubes on each side as described by Cary (1902) in *Anaphothrips striata*. In one case, however, I found nine ovarioles lying in groups of five and four ovarian tubes in *Aptinothrips rufus*, but this may be considered abnormal. The ovarioles in some species are short and contain fewer oocytes, and in others long and contain several. This depends partly on the breeding period. During the hibernation period, the ovary is much attenuated.

In *Odontothrips ulicis*, the ovary, at breeding time, is a very long structure composed of eight ovarioles (pl. XV, fig. 3). Each ovariole is divisible into three parts as in *A. rufus*. There are a greater number of oocytes arranged in a chain. The ovarioles open into the paired oviduct which posteriorly form the common duct. This widens out a little posteriorly to form the vagina. In the middle of the common duct is situated the brown body (pl. XV, fig. 3), characteristic of most species of Thysanoptera. Slightly below, opens the duct from the receptaculum seminis. Anteriorly the terminal filaments join to form a ligament which is connected with the posterior connective tissue of the short salivary glands. In *L. cerealium* also the terminal filaments form a ligament which joins with the connective tissue of the short pair of salivary glands.

In *Heliothrips haemorrhoidalis*, however, the terminal filaments from each group of ovarioles of either side join separately with the posterior part of the short salivary glands which are separate. This connection of the terminal filament with the short salivary glands is different from that in the above species, and my observations confirm Buffa's finding.

In *Haplothrips distinguendus* (Tubulifera), the ovary is similarly composed of eight tubules, arranged in groups of two and lying similarly as in other species (pl. XV, fig. 4). Each ovarian tube is similarly composed of three parts with a mature oocyte at the base (pl. XV, fig. 5). Anteriorly the four ovarian tubes of each side join to form a thick connective tissue which is connected with the long pair of separate salivary glands, by a fine thread-like filament (pl. XIII, fig. 4). In this it differs from other Terebrantia.

The receptaculum seminis differs slightly in shape and the length of duct in various species. In *Odontothrips ulicis* (pl. XV, fig. 3) it is more or less oval, retort-like, with a very short duct opening directly into the vagina. In *Limothrips cerealium*, it is more or less a similar flat structure, with a moderately long duct, opening into the vagina. The sides and body are lined with cells having prominent nuclei. In the duct the outgoing canal is also seen (pl. XVI, figs. 2–3). In *Thrips tabaci*, it is spherical at the end, bent inwards, with a long winding duct (pl. XVI, fig. 4). The canal is also seen throughout the whole length of the duct. In *H. haemorrhoidalis*, it is rounded or globular with a very short duct similar to that shown by Buffa. The cells lining the walls are

fairly long (pl. XVI, fig. 5). In *Haplothrips distinguendus* (Tubulifera) the receptaculum seminis is a long bladder-shaped structure, with a fine duct, opening directly into the vagina. The duct slightly widens out before opening in the vagina. No ampulla-like structure is found in the duct as shown by Jordan (1888) in *Phloeothrips brunnea* and Uzel (1895) in *Trichothrips copiosa*, but the widening may be homologised with that. The receptaculum seminis is brownish in colour and is filled with a fluid having a dense collection of sperms. Cary (1902) did not find any well-marked receptaculum seminis or accessory sac in *Anaphothrips striata*.

(b) *Male.*

In *Aptinothrips rufus*, both sexes are wingless, and the males are externally distinguished chiefly by their short size and the form of the last abdominal segment which is bluntly rounded. Dorsally the abdominal rings are complete and the divisions of the eighth, ninth and tenth abdominal terga are easily distinguished. The ninth and tenth sternal plates appear to be fused, forming a single median plate. The male genitalia are carried by the fused ventral plate and consist of a pair of rods or claspers and a median unpaired rod, the penis or oedeagus. The penis is a yellowish chitinous structure wider basally and thinner distally. The paired rods or claspers are also chitinous and are closely applied to the greater part of the median penis. Basally the claspers form curved chitinous thickenings which enclose the thicker base of the penis.

Internally the reproductive organs consist of a pair of saffron-yellow testes lying in the 6–7 or 7–8 abdominal segments. Each is a more or less club-shaped structure composed of four chambers in some, which are filled with spermatozoa (pl. XVII, fig. 1). The testes are about 108 μ long and 28 μ wide at the top. Posteriorly they are connected with a pair of clear white vasa deferentia 55 μ long and 8 μ wide, which open separately into the bulbous part of the ductus ejaculatorius. Slightly before they open into the ejaculatory duct, they widen out a little, and the swelling thus produced may be homologised with the vesiculae seminales of other insects. The vesicula seminalis is not pouch-shaped, but is simply the widened posterior part of the vas deferens. Another very prominent structure associated with the reproductive organs is a pair of clear translucent white accessory glands. They are long bladder-shaped structures slightly constricted in the middle, and wider proximally and distally. In plate XVII, fig. 1, the left accessory gland is slightly distorted at the top; while the right one is normal. In stained preparations (pl. XVII, fig. 3) the sides and the whole wall of the accessory glands are composed of large cells having prominent nuclei (5 μ across). The glands measure 143 μ in length; and 36 μ wide at the top, 33 μ in the middle and 43 μ at the base. The accessory glands open separately by very minute openings into the bulbous part of the ejaculatory duct. The openings of the vasa deferentia and the accessory glands appear to be close together. The ejaculatory duct consists anteriorly of a bulb-shaped (pl. XVII, fig. 4) highly muscular structure (28 μ across), into which open the accessory glands and vasa deferentia. Posteriorly it continues its course as a fine canal to the intromittent organ. The spermatozoa in *Aptinothrips* lie in the chambers of the testes (pl. XVII, fig. 2) and are very small, flagella-like bodies, measuring about 1 μ in length.

In *Limothrips cerealium*, the testes are saffron-yellow, wider at the top, and more or less club-shaped (pl. XVII, fig. 5) as in *A. rufus*. They do not appear to be divided into chambers; and in the anterior, wide; part a mass of

spermatozoa can be seen. The testes are about 196 μ long and 59 μ wide at the top. Posteriorly, the vasa deferentia are very thin, translucent white and slightly widen out before opening into the bulbous part of the ejaculatory duct. There are also two pairs of long, cylindrical accessory glands; about 196 μ long and 48 μ wide in the middle. They have a cellular structure and open separately into the ejaculatory duct, but are not constricted in the middle. The ejaculatory duct is bulbous anteriorly, as in *A. rufus*, and this wide part is about 55 μ long and 40 μ wide. Posteriorly it continues backward as a fine canal. Associated with this thin part is a structure with very weak musculature and having small scattered nuclei. Klocke (1926) calls this part " Ringmuskel des Ductus ejaculatorius " in *Thrips physopus* ; and it appears that a similar structure is also present in *L. cerealium.*

In *Taeniothrips vulgatissimus*, the testes and vasa deferentia are all coloured with an orange-yellow pigment, and no demarcation of orange-yellow testes and white tubular vasa deferentia are present (pl. XVII, fig. 6). The whole part is about 114 μ long. In the absence of any differentiation, the anterior part will be called testes and the posterior vasa deferentia. The testes are pear-shaped about 44 μ wide. The vasa deferentia are short, thicker, concolorous with the testes and before opening into the ejaculatory duct, widen out much more than in the previous species to form vesiculae seminales. The accessory glands are round or spherical, short structures about 66 μ long and 48 μ wide. These open separately into the anterior chamber of the ductus ejaculatorius, which is smaller than in other species. The bulbous part of the duct is about 25 μ long and 22 μ wide.

In *Taeniothrips atratus*, the testes and vasa deferentia are orange-yellow as in *T. vulgatissimus* and measure about 151–188 μ in length (pl. XIX, fig. 1). The testes are pyriform, about 51 μ wide in the middle. Posteriorly the vasa deferentia are short, thick, concolorous with the testes, and widen out before opening into the anterior chamber of the ductus ejaculatorius. The accessory glands are paired, large, bladder-shaped structures, about 111 μ long and 62 μ wide, longer and wider than in *Taeniothrips vulgatissimus.* The accessory glands have a cellular structure and open separately into the anterior chamber of the ejaculatory duct as in other species. The bulbous part of the ejaculatory duct is 37–48 μ long and 33–52 μ wide. Posteriorly the duct is fine, and is associated with the ring musculature, as in *L. cerealium.* The most unusual structure noted in this species is the presence of a commissure which connects the two testes (pl. XIX, fig. 1). The commissure is concolorous with the testes and is very delicate, breaking away in dissection if the reproductive organs are not carefully manipulated. So far as is known, this connection has not been noted in any other species of thrips.

In *Odontothrips ulicis*, the testes and vasa deferentia are similarly pigmented and are short, saffron-yellow or orange-yellow, measuring 155 μ in length (pl. XVIII, fig. 1). The testes are club-shaped, short, about 59 μ wide in the middle (pl. XVIII, figs. 1, 3). The vasa deferentia are very short tubes which widen slightly before opening into the ejaculatory duct as in all the previous species (pl. XVIII, fig. 3). The accessory glands are paired, round and small, about 85 μ across, and open separately into the ejaculatory duct. In stained preparations, these appear to have a cellular wall with prominent nuclei (pl. XVIII, fig. 2). The anterior chamber of the ejaculatory duct is much more prominent in comparison with other structures and is very long and wide, quite unlike what is found in any other species of thrips. It measures ·205 mm. in length and ·110 mm. in width in the middle. Posteriorly it is continuous

with a fine thin duct going to the intromittant organ. Associated with this part is a structure showing weak musculature and scattered nuclei (pl. XVIII, fig. 4) which has been previously called the ring musculature of the ductus ejaculatorius. Connected with the posterior chitinous part is another structure concolorous with the testes, and is designated here the third unpaired gland (pl. XVIII, figs. 1, 5). It is about ·221 mm. long and ·078 mm. wide. This gland is a large, orange-yellow, bladder-shaped structure and is filled with a slightly viscous brownish fluid. The exact function of this gland is not known, but probably the fluid is used during copulation. This gland is so characteristic, that it can be seen separate from the testes, even through the dark chitinous body wall of males. It has not been previously noted in Thysanoptera.

In *Melanthrips fuscus* (Aeolothripidae), the testes are orange-yellow, pyriform, differentiated from the posterior short vasa deferentia, by colour (pl. XVIII, fig. 6). Each testis is about 51 μ wide and contains spermatozoa. Posteriorly the vasa deferentia are very short and pale, opening by small thickened bases into the anterior chamber of the ductus ejaculatorius. The accessory glands are paired and spherical, opening separately into the bulbous part of the ejaculatory duct. The anterior chamber of the ejaculatory duct is wide, as found in most Thripids and is 55 μ long and 40 μ wide. Posteriorly it is continuous as a small, thin canal as in other species of thrips.

In *Haplothrips distinguendus* (Tubulifera), the testes are long, wide, lanceolate (or in some, spindle-shaped) structures covered with dark reddish pigment (pl. XIX, fig. 2). Occasionally specimens are found in which the testes are sub-globular and bilobed. Posteriorly they are connected with long thin vasa deferentia which widen posteriorly to form long vesiculae seminales in which a large collection of spermatozoa may be seen. These finally open into the ejaculatory duct. Unlike what is found in the Terebrantia, there are two pairs of accessory glands. The first or the outer pair is long, wide, bladder-shaped, about ·378 mm. long and ·11 mm. wide (pl. XIX, fig. 4). Posteriorly each opens by a short canal into the ejaculatory duct. The second or the inner pair is shorter and thinner about ·284 mm. long and ·078 mm. wide, opening similarly by a short duct into the ductus ejaculatorius. Either of the two pairs of glands may be deformed and shorter. The openings of the accessory glands, and the vasa deferentia are very closely situated, and the ejaculatory duct is very thin. In stained preparations, the walls of both pairs of glands appear to be composed of flat, polygonal, large cells, in each of which large round nuclei may be seen (pl. XIX, figs. 3–4).

7. References.

Buffa, P., 1898, Contributo allo studio anatomico della *Heliothrips haemorrhoidalis*, Fabr. Riv. Path. veget., **7**, (1) 11 : 1–30, pls. 5–9.

Cary, L. R., 1902, The grass thrips (*Anaphothrips striata*, Osborn). 18th Ann. Rep. Maine Agric. Expt. Stat., Orono, : 97–128.

Jordan, K., 1888, Anatomie und Biologie den Physapoda. Z. wiss. Zool., **47** : 541–620, pls. 36–38.

Klocke, F., 1926, Beiträge zur Anatomie und Histologie der Thysanopteren. Z. wiss. Zool., **128** : 1–36, pls. 1–3.

Peterson, A., 1915, Morphological Studies in the Head and Mouth-parts of the Thysanoptera. Ann. Ent. Soc. Amer., **8** : 20–59.

Priesner, H., 1928, Die Thysanopteren Europas, **1–4.**

Radulesco, E., 1930 (1931), Recherches biologiques et cytologiques sur quelques Thysanoptères. Ann. Epiphyt., **16** : 103–188.

Uzel, H., 1895, Monographie der Ordnung Thysanoptera, Königgratz.

8. Lettering and Explanation of Plates.

Lettering.

6s–10s = six to ten segments.
a. = antenna.
an. = anus.
at. = anterior.
a.ch.ej.d. = anterior chamber of ejaculatory duct.
a.o.n. = antennal-ocellaris nerve.
a.gl. = abdominal ganglion.
ac.gl. = accessory gland.
br. = brain.
br.b. = brown body.
c. = cell.
ca. = canal.
ch. = chorion.
cl. = clypeus.
co. = constriction.
com. = commissure.
cr. = crop.
ct. = connective tissue.
c.d. = common duct.
c.g. = chitinous thickening.
dt. = duct.
d.ej. = ductus ejaculatorius.
d.s.sg. = duct of short salivary glands.
e. = eye.
em. = embryo.
em.a. = embryonic area.
em.sp. = embryonic spherules.
f. = filament.
fr. = frons.
f.e. = follicular epithelium.
f.i. = fore-intestine.
f.m.i. = front portion of mid-intestine.
g. = glandular part.
ge. = germarium.
gl. = third unpaired gland.
gr. = groove.
g.c.d. = grand common duct (main duct).
hyp. = hypopharynx.
h.i. = hind-intestine.
h.m.i. = hind portion of mid-intestine.
i. = ilium.
l. = left.
la. = labium.
lbr. = labrum.
le. = leg.
li. = ligament.
lr. = leg rudiment.
lu. = lumen.
l.md. = left mandible.
l.p. = labial palp.
l.sg. = long salivary gland.
md. = mandible.
m.gl. = mesothoracic ganglion.
m.i. = mid-intestine.
m.t. = malpighian tube.
mt.gl. = metathoracic ganglion.
mu. = musculature.
mx.pl. = maxillary palp.
mx.s. = maxillary sclerite.
mx.st. = maxillary stylet.
n. = nucleus.
ne. = nerve.
n.ch. = nerve chord.
ocel. = ocellus.
od. = oviduct.
oe. = oesophagus.
o.g. = optic ganglion.
ov. = ovariole.
oy. = oocyte.
p. = pore.
ph. = pharynx.
pos. = posterior.
pro. = protoplasm.
p.g. = post-glandular part.
p.gl. = prothoracic ganglion.
pr.g. = pre-glandular part.
r. = rectum.
rd. = ridge.
re. = reservoir.
r.g. = rectal gland.
rt. = right.
r.m. = ring musculature of ejaculatory duct.
r.md. = right rudimentary mandible.
r.s. = receptaculum seminis.
sp. = sperms.
su. = suture.
s.sg. = short salivary gland.
t. = testis.
te. = teeth.
t.f. = terminal filament.
vac. = vacuole.
vag. = vagina.
vit. = vitelline membrane.
v.d. = vas deferens.
v.s. = vasicula seminalis.
w.d. = widening of the duct.
y. = yolk.

Explanation of Plates X–XIX.

Plate X.

Fig. 1. Alimentary canal of *Aptinothrips rufus.*
2. Hind part of the alimentary canal of *Aptinothrips*, showing the insertion of malpighian tubes, division of hind-gut and the presence of four rectal glands.
3. Hind-gut of first stage larva of *Aptinothrips*, showing the presence of four rectal glands.
4. Alimentary canal of *Heliothrips haemorrhoidalis*, showing the origin of long salivary glands and the enlarged mid-intestine.
5. Hind-gut of *H. haemorrhoidalis* showing the insertion of malpighian tubes, and four rectal glands.

Plate XI.

Fig. 1. Alimentary canal of *Melanthrips fuscus.*
2. Hind-gut of *M. fuscus* showing the insertion of malpighian tubes and the presence of five rectal glands.
3. Alimentary canal of *M. fuscus*, showing the abnormal fore mid-intestine.
4. Alimentary canal of *Haplothrips distinguendus.*
5. Hind-gut of *H. distinguendus*, showing the insertion of malpighian tubes, ampulla-like ilium, and the presence of four rectal glands.
6. Long salivary gland of *M. fuscus.*

Plate XII.

Fig. 1. Anterior part of the alimentary canal of *Aptinothrips*, showing the anterior course of ducts from two pairs of salivary glands.
2. Short pair of salivary glands in *Aptinothrips.*
3. Long salivary gland of *A. rufus.*
4. Short pair of salivary glands in *L. cerealium.*
5. Short pair of salivary glands in *Odontothrips ulicis.*
6. Fat-body in *Aptinothrips rufus.*
7. Two cells of the same fat-body, showing vacuolated appearance.

Plate XIII.

Fig. 1. Short salivary gland in *Melanthrips fuscus.*
2. First kind of short and thin salivary gland in *H. haemorrhoidalis.*
3. Short and thick salivary gland of *H. haemorrhoidalis.*
4. Two pairs of salivary glands in *Haplothrips distinguendus*, showing posteriorly the connection with the ovary.
5. Short salivary gland in *H. distinguendus.*
6. Long salivary gland in *H. distinguendus.*

Plate XIV.

Fig. 1. A part of the malpighian tube in *A. rufus.*
2. Nervous system of *Aptinothrips rufus.*
3. Larval brain of *A. rufus.*
4. Nervous system of *Limothrips cerealium.*
5. Nervous system of *Haplothrips distinguendus.*
6. Normal ovary of *Aptinothrips.*
7. A single ovariole from *A. rufus* ovary.
8. Terminal part of an ovariole showing germarium and oocytes.

Plate XV.

Fig. 1. Abnormal ovary of *Aptinothrips rufus.*
2. Receptaculum seminis of *A. rufus.*
3. Female reproductive organs of *Odontothrips ulicis.*
4. Female reproductive organs of *Haplothrips distinguendus.*
5. A single ovariole from the ovary of *H. distinguendus.*
6. Receptaculum seminis of *H. distinguendus.*

Plate XVI.

Fig. 1. An advanced stage embryo of *Limothrips cerealium,* showing the presence of paired maxillary stylets and a single thick mandible.
2. Receptaculum seminis of *L. cerealium.*
3. Receptaculum seminis of *L. cerealium,* showing the cellular outline.
4. Receptaculum seminis of *Thrips tabaci.*
5. Receptaculum seminis of *Heliothrips haemorrhoidalis.*
6. Fat-body of *L. cerealium.*
7. Enteric epithelium from the mid-intestine of *Aptinothrips rufus.*

Plate XVII.

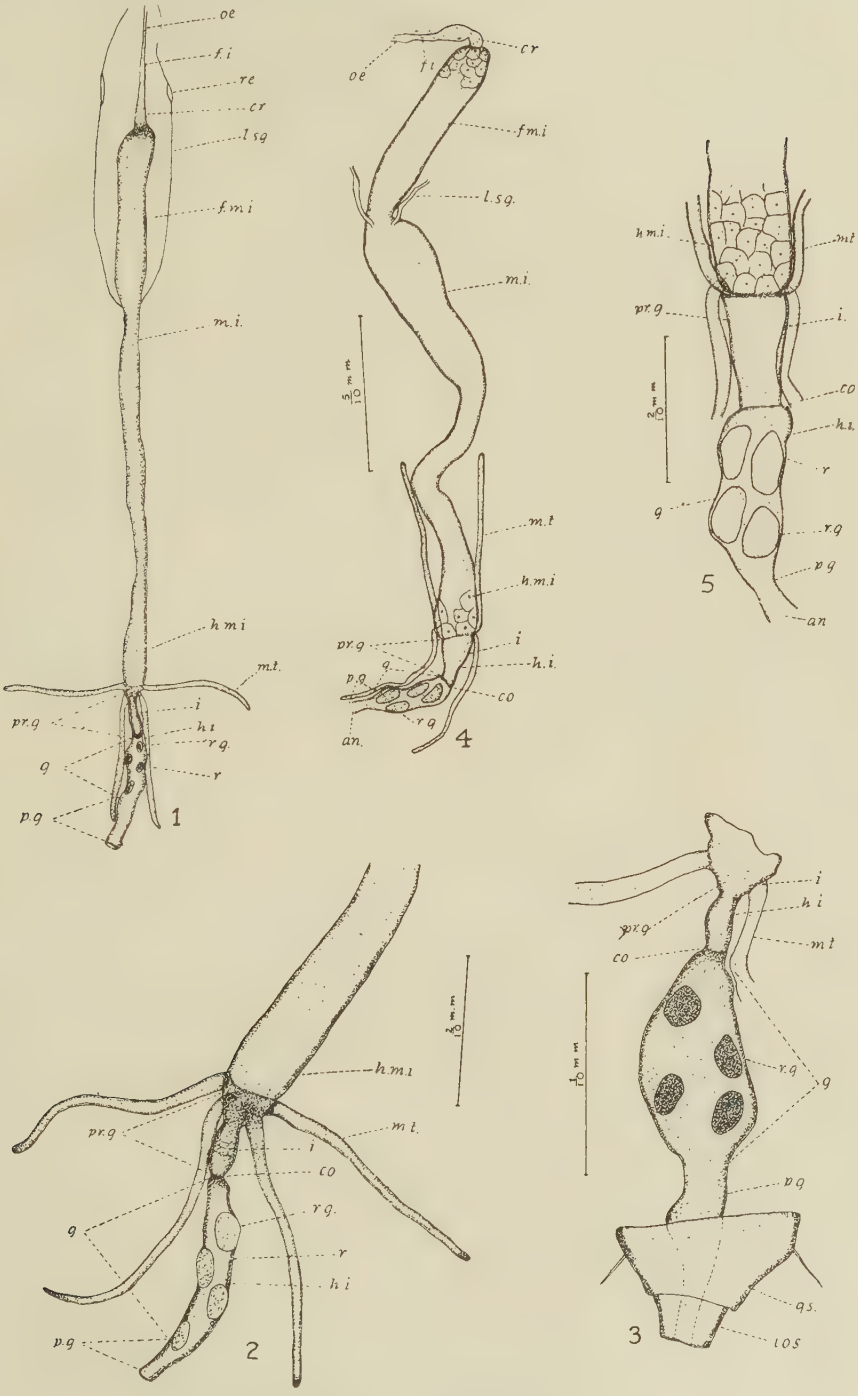
Fig. 1. Male reproductive organs of *Aptinothrips rufus.*
2. Testis, vas deferens and short vesicula seminalis of *Aptinothrips.*
3. Accessory gland of male *A. rufus.*
4. Anterior muscular chamber of ejaculatory duct of *A. rufus.*
5. Male reproductive organs of *L. cerealium.*
6. Male reproductive organs of *Taeniothrips vulgatissimus.*

Plate XVIII.

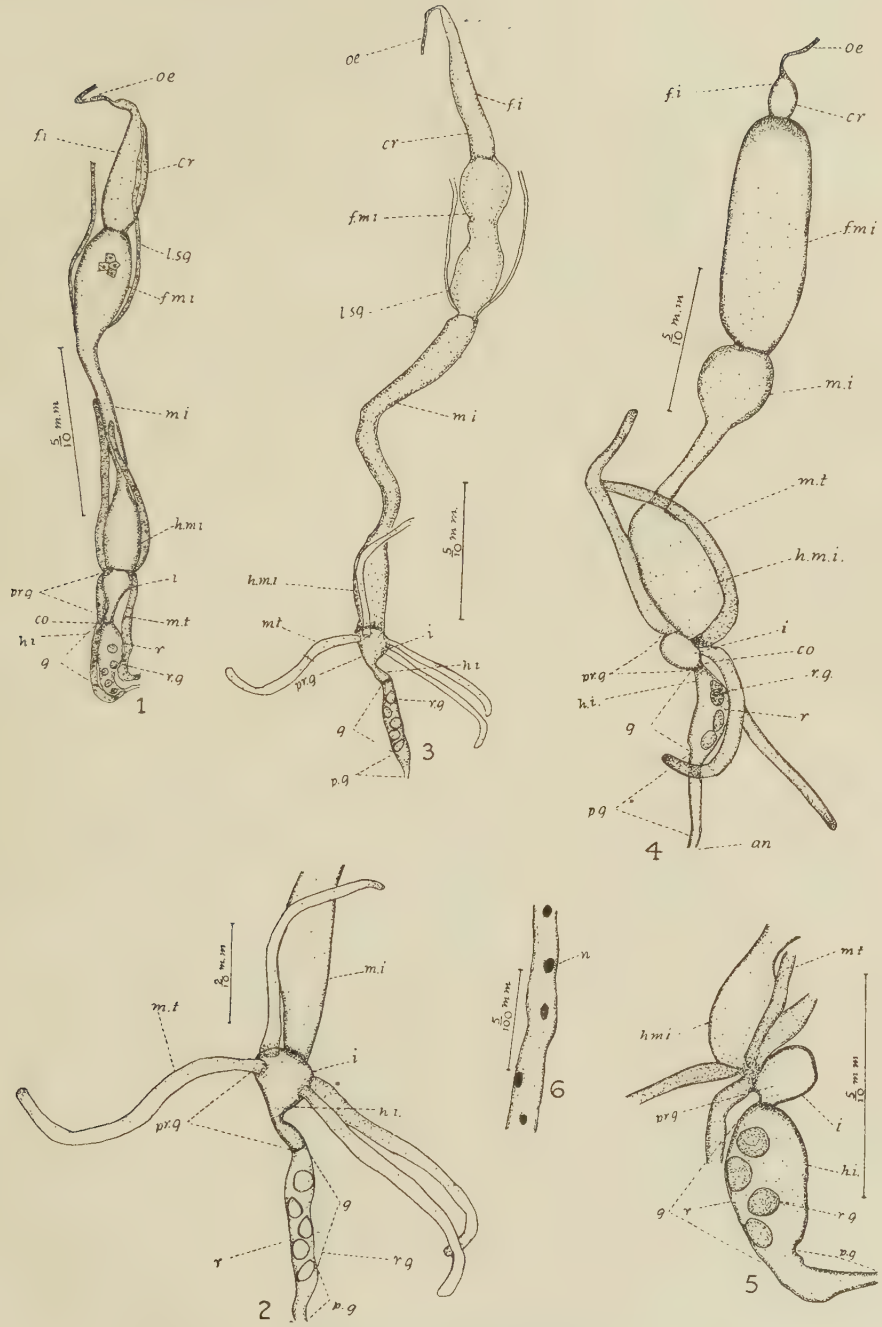
Fig. 1. Male reproductive organs of *Odontothrips ulicis.*
2. Accessory gland of male *O. ulicis.*
3. Testis, vasa deferens and vesicula seminalis of *O. ulicis.*
4. Ring musculature of ejaculatory duct.
5. Third unpaired gland in male *O. ulicis.*
6. Male reproductive organs of *Melanthrips fuscus.*

Plate XIX.

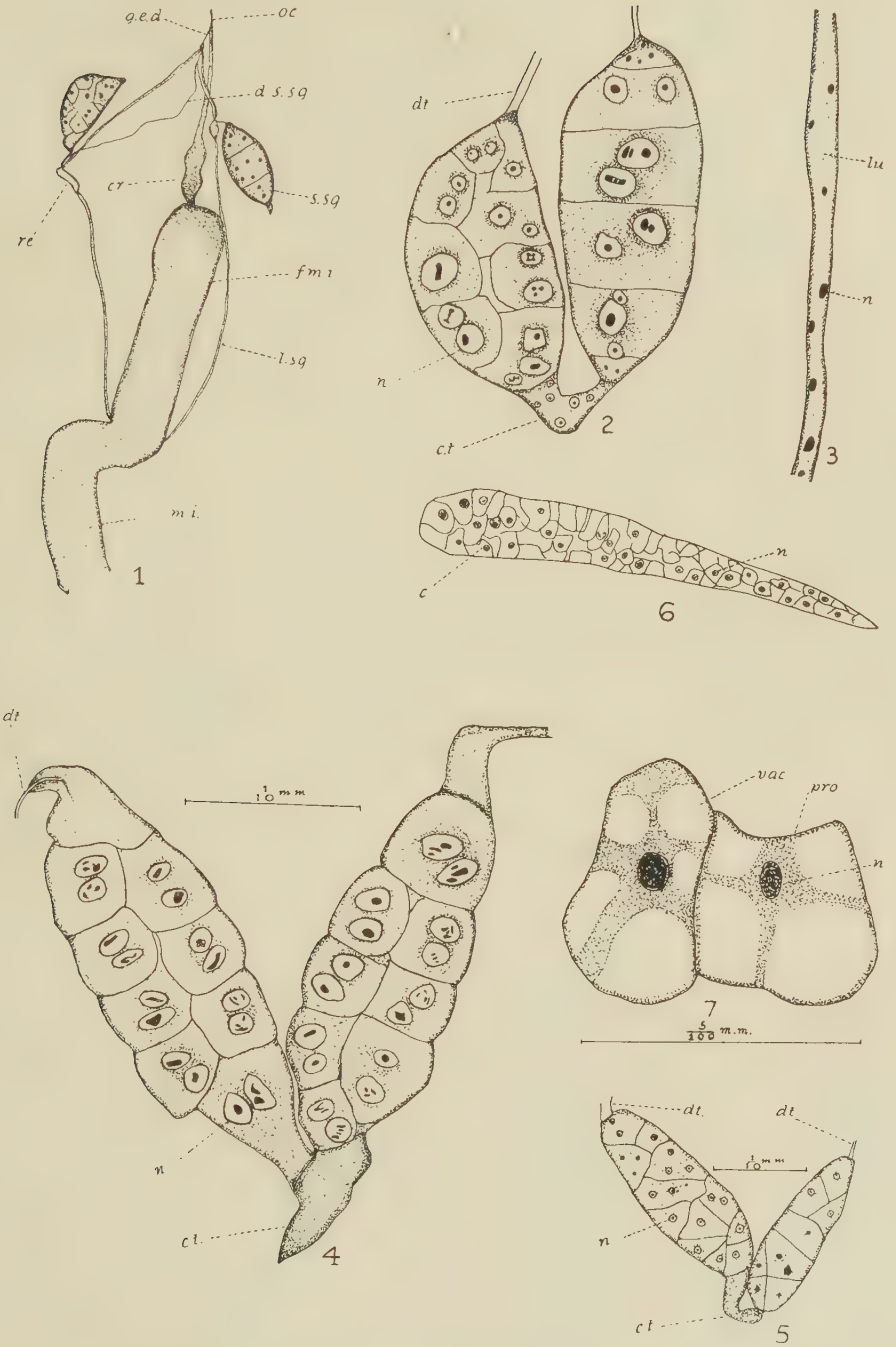
Fig. 1. Male reproductive organs of *Taeniothrips atratus,* showing the connection between the two testes.
2. Male reproductive organs of *Haplothrips distinguendus.*
3. Short accessory gland of *H. distinguendus.*
4. Long and large accessory gland of *H. distinguendus.*
5. A single cell from the accessory glands, highly magnified.



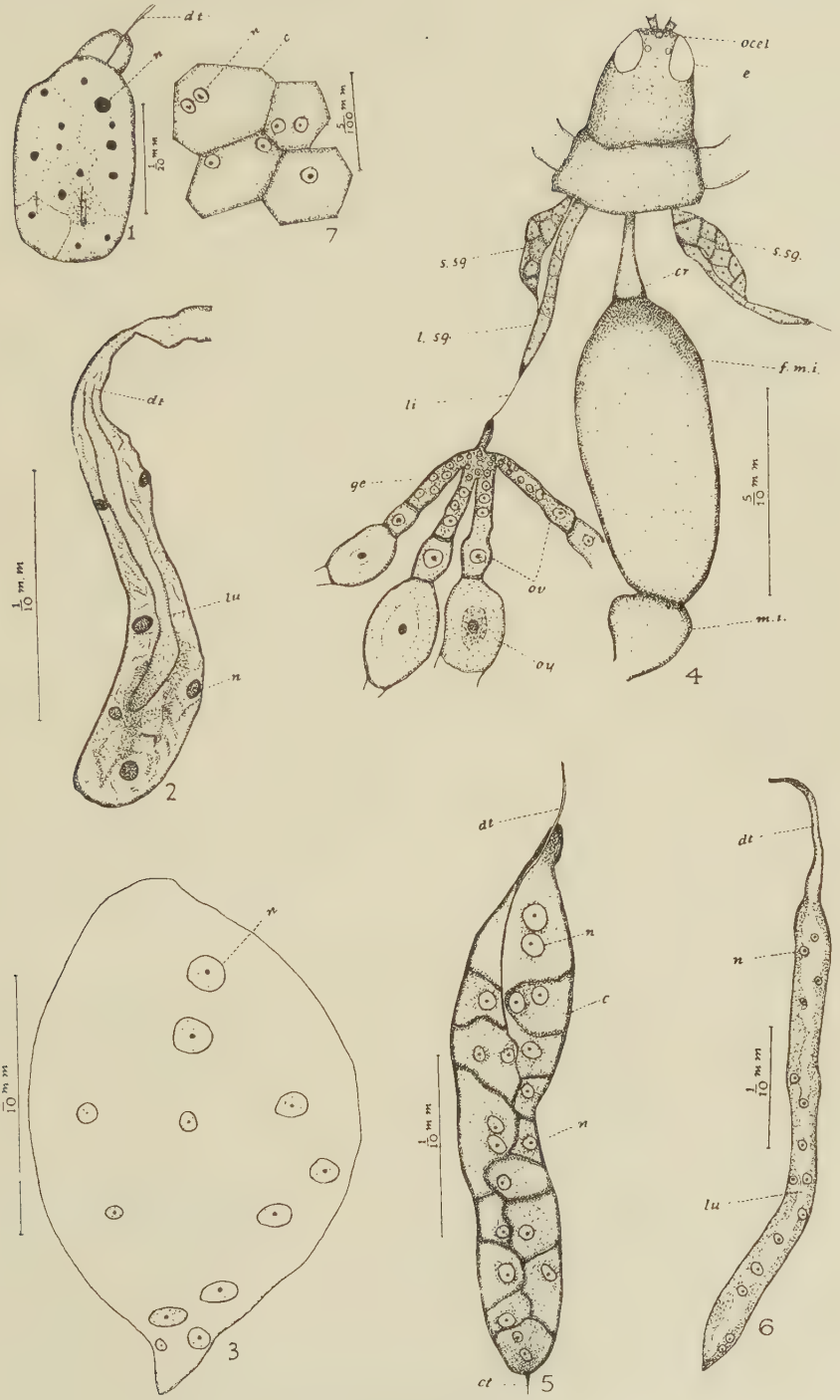
Anatomy of Thysanoptera.



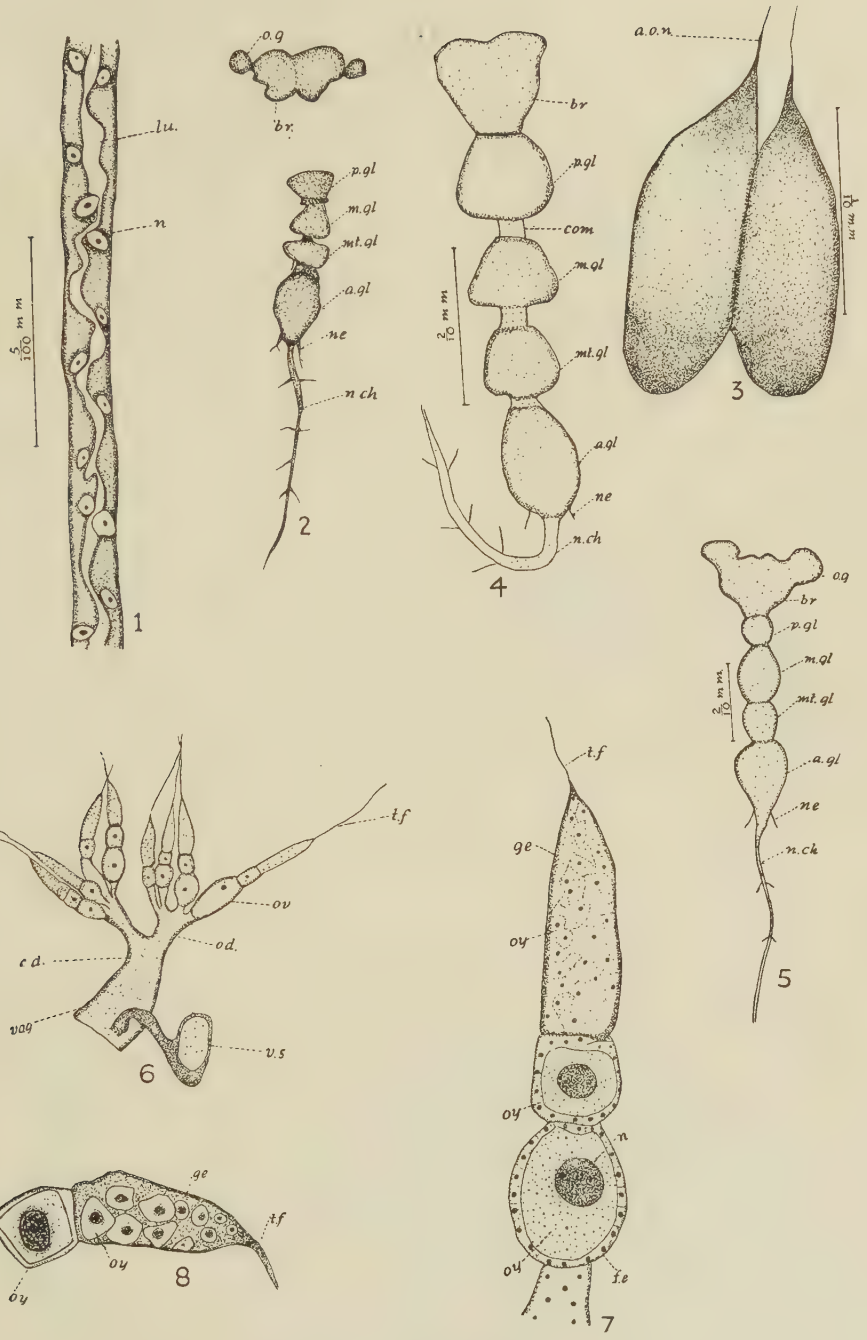
Anatomy of Thysanoptera.



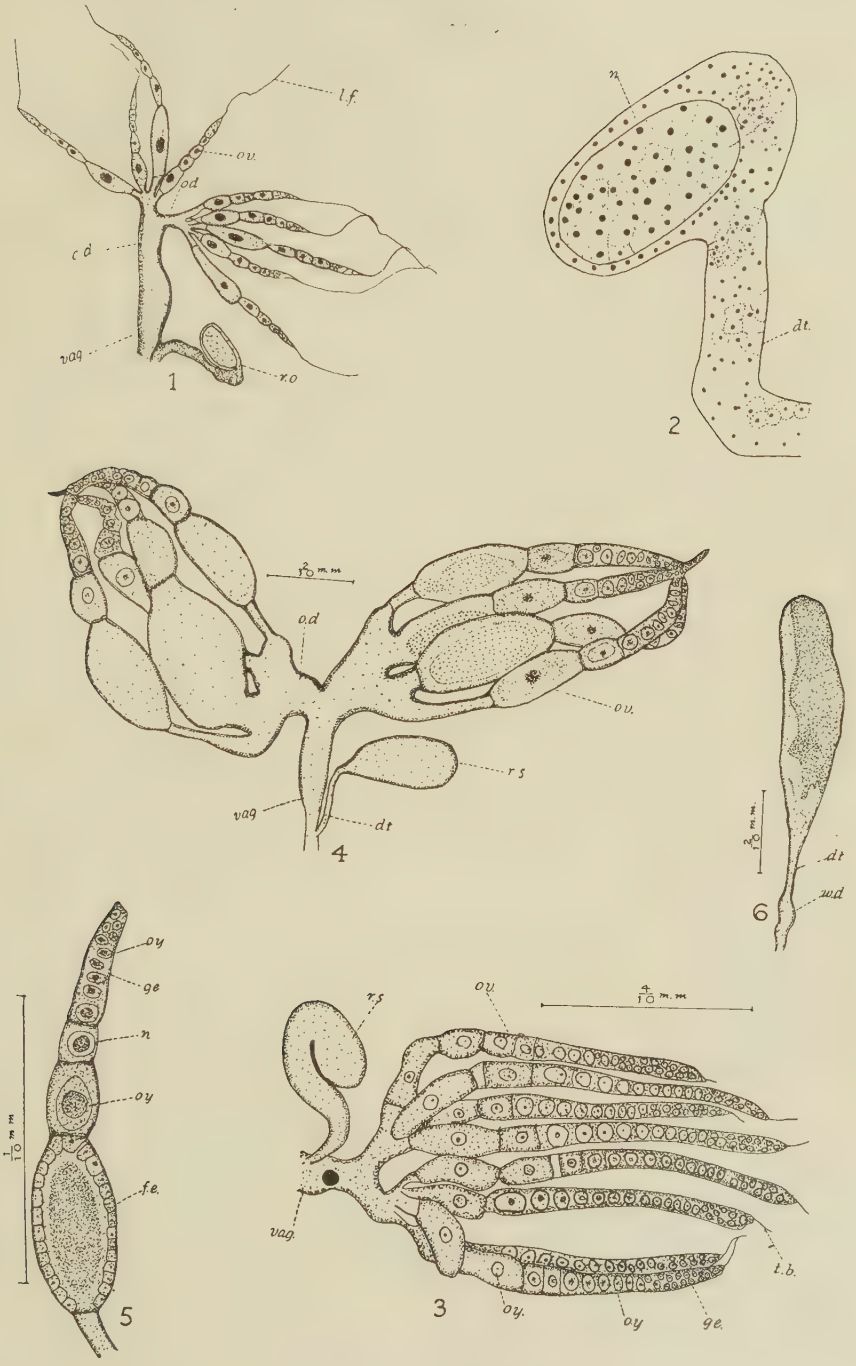
Anatomy of Thysanoptera.



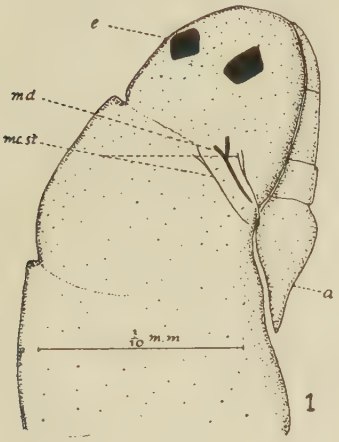
Anatomy of Thysanoptera.

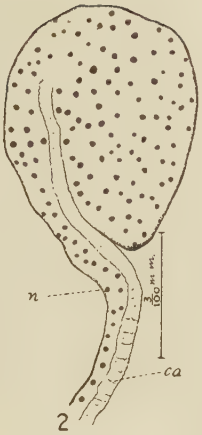


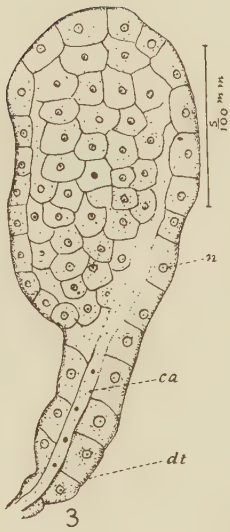
Anatomy of Thysanoptera.

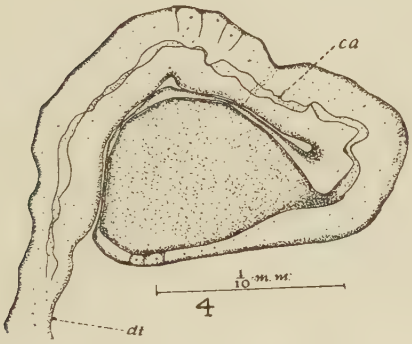


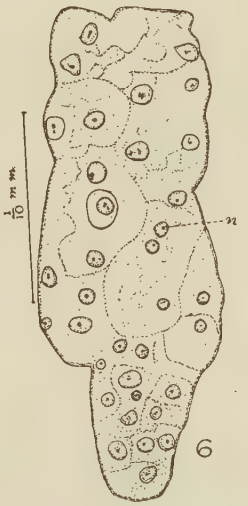
Anatomy of Thysanoptera.

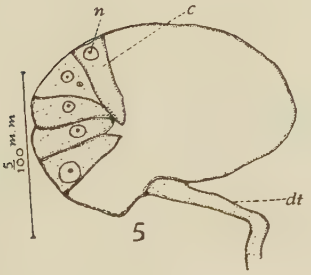


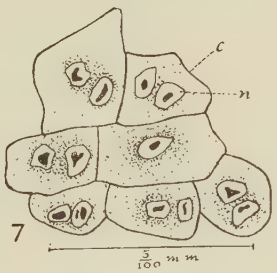




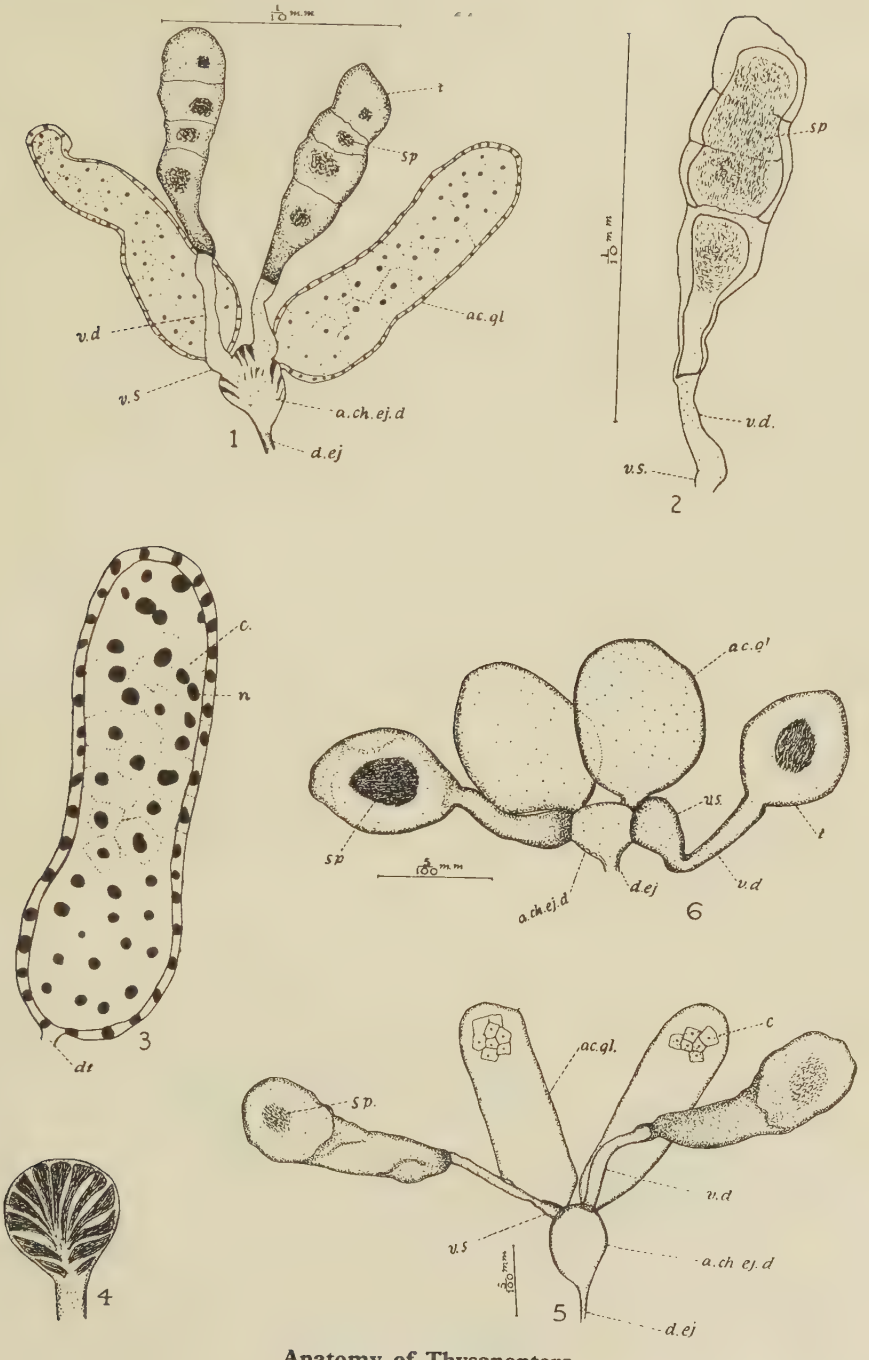




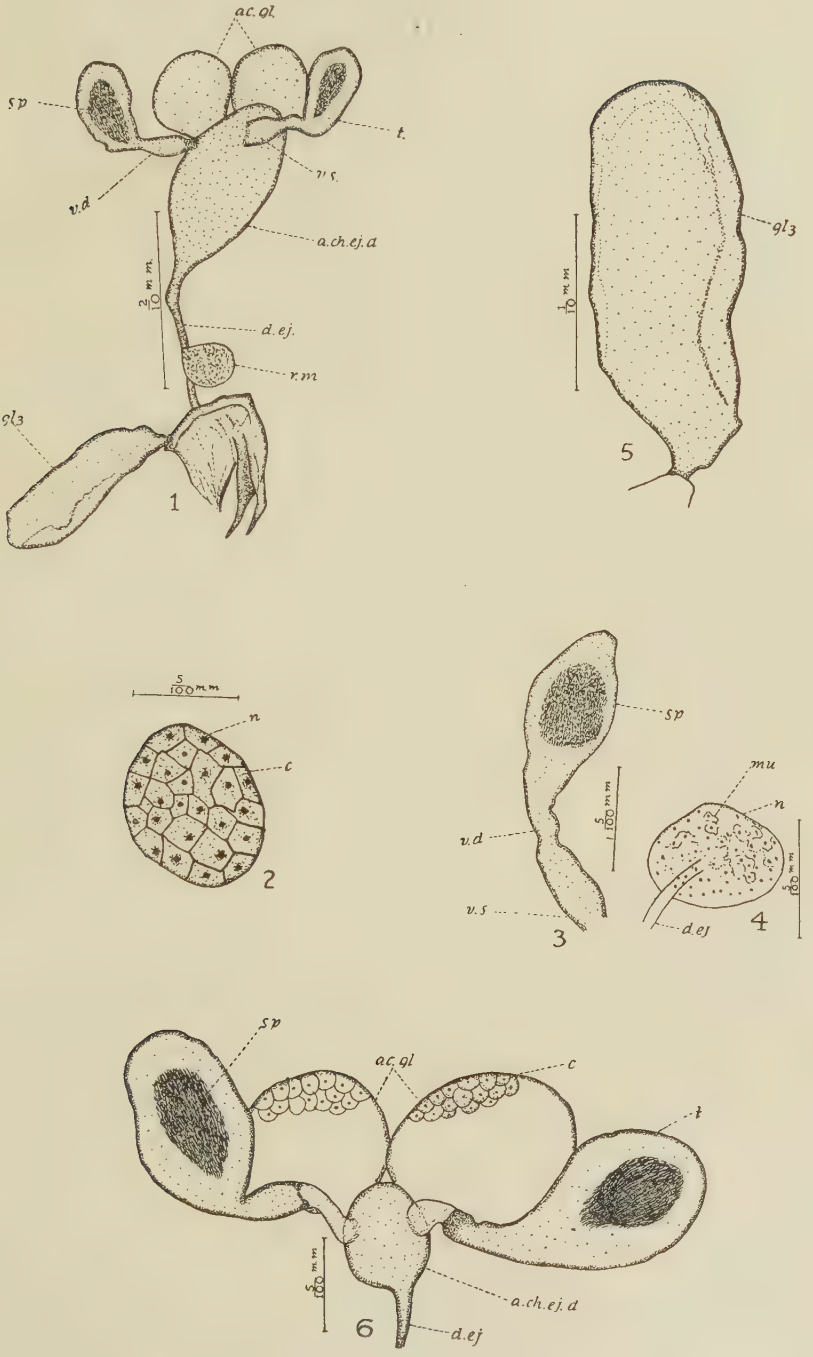




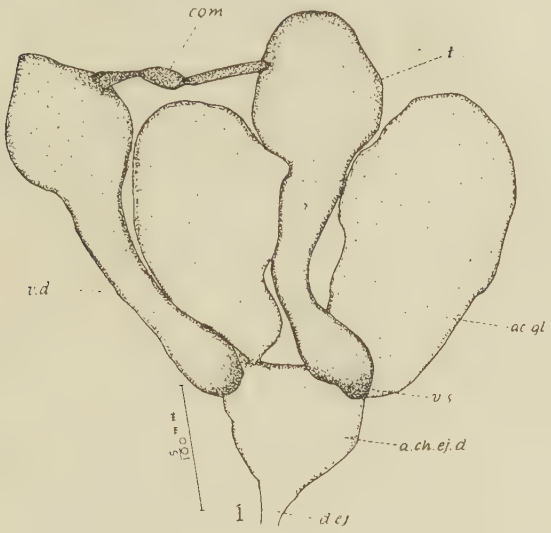
Anatomy of Thysanoptera.

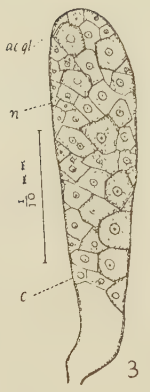


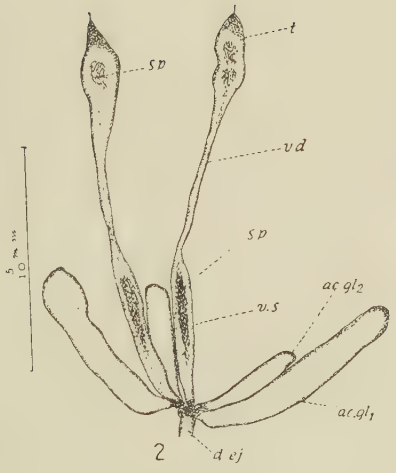
Anatomy of Thysanoptera.

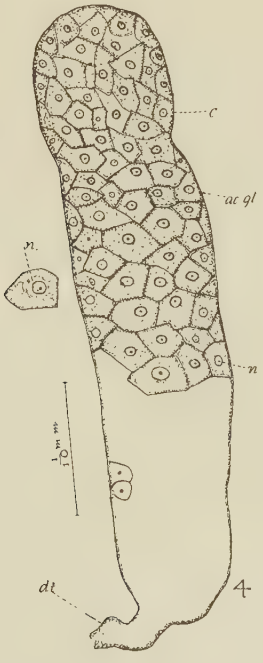


Anatomy of Thysanoptera.









Anatomy of Thysanoptera.

ON AN ADVANCE OF TSETSE-FLY IN CENTRAL TANGANYIKA

By C. H. N. Jackson, Ph.D., M.Sc.

(Department of Tsetse Research, Tanganyika Territory.)

[Read 7th June, 1933.]

With one Map.

Contents.

		page
I.	Introduction	205
II.	The Nature of the Country	206
III.	History of the Advance	210
IV.	Factors Favouring or Retarding the Advance	216
V.	The Mechanism of the Advance	218
VI.	The Future of the Advance	220
VII.	Summary	221

I. Introduction.

Within the present century a belt or colony of the tsetse-fly, *Glossina morsitans*, has spread from its point of origin in the north-eastern corner of the Central Province of Tanganyika Territory to a distance of some 50 miles south-westwards, covering large areas of the western Kondoa-Irangi, southern Mbulu, and eastern Singida districts with a fly-belt approximately 30 miles in width. This advance, which is still proceeding, has depopulated large areas of well-wooded country and has driven out on all sides the several native tribes with their surviving cattle and goats. Their influx into other areas has caused acute overgrazing and erosion of the surrounding country that is still fly-free, while the threat of sleeping sickness hangs over those numerous small settlements that, following the loss of all their domestic animals, remain in the fly-infested bush. This and the other advances of tsetse threaten the domestic animals of entire native tribes, the territories of which are even now suffering from those preliminary evils of congestion that lead to exhaustion of water-supplies and impoverishment of the soil. The advance thus spells complete economic disaster to the areas that it invades, and it therefore demands a study of its characteristics and causes.

The author's acquaintance with this country dates from March 1928, when general studies on the bionomics of *Glossina morsitans* were initiated at Sambala (1930, Bull. Ent. Res., **21** : 491). These investigations lasted until October 1929, and a short visit was paid to the area in October 1930. In October 1931 the author returned to the study of the fly-belt, using as a base the settlement of Masiliwa, about 20 miles west of Sambala. Studies on the bionomics of tsetse and the boundaries of the fly-belt were carried on at intervals until September 1932. The studies on the mechanism of the advance are in a very unfinished condition, but a close acquaintance with the fly-belt and its recent advances may justify some account of the work so far as it has progressed up

to now, while the contributions of other workers to the history of the advance are of such intrinsic value as to demand their compilation.

II. The Nature of the Country.

Topography.

The reader should consult two papers of Obst for a graphic and most interesting account of his travels in the area, with numerous photographs and maps, meteorological and other data. (Obst, E., 1915 and 1923. "Das abflusslose Rumpfschollenland im nordöstlichen Deutsch-Ostafrika," Mitt. Geogr. Ges., Hamburg, **29**, **35**.)

Roughly speaking, the area lies between 4° 30′ and 5° 30′ south latitude, and between 35° 0′ and 35° 40′ east longitude. The general elevation of the country is from 4,000 to 5,000 ft. above sea-level, but individual hills attain heights up to about 700 ft. above the surrounding country.

The Bubu river on the east, and the Mponde in the Rift Valley on the west, form convenient boundaries. East of the Bubu, is the Irangi Plateau with a large native population; west of the Mponde, the precipitous Rift Wall rises some 1,500 ft. above the valley below. Both rivers flow south to enter a large swamp south of the Central Railway, with no outlet to the sea. The remaining river of importance is the Mekenke or Jojo, which rises in the north-middle portion of the area, and flows at first south and then south-east to join the Bubu. The south-east corner of the area is formed by the confluence of the Bubu and Mekenke; the south-west corner is at the point at which the Mponde enters the great Sanzawa thicket. Between these two points the southern boundary of the area is formed by the north side of the southern block of Sandawe hills. On the north the area is bounded by the open Mangati Plains.

The fly-infested country is connected in the extreme north-east corner by a scanty tsetse population crossing the Irangi Plateau, here called, at this point, the Bereku Ridge. The eastern Kondoa *G. morsitans* fly-belt, lies along the eastern base of the plateau at the edge of the Masai Steppe.

The geological formation is mainly granite and gneiss, occasionally diabasic greenstone and pegmatite. The granite appears to predominate in the south and west, the gneiss in the north-east. (Herzenberg, R., *see* Obst, 1915, *tom. cit.*, p. 145 *et seq.*)

In the west of the area is found the hard yellow duricrust characteristic of the "Itigi thicket" country (Phillips, J. F. V., 1930, "The principal vegetation communities in the Central Province, Tanganyika Territory," J. Ecol. **18**) of the Manyoni District of the Central Province, and supporting similar thicket. Farther east the thicket is of a different type on reddish soils.

The grey eluvial soils, of very light consistency, which cover most of the undulating hills, support open "miombo" (*Berlinia-Brachystegia*) woodland with poor grass growth that burns patchily in the seasonal grass-fires.

The larger seasonal swamps are characterised by deeply-cracking "black cotton" alluvial soils, supporting either a very coarse growth of grass with few trees, or a thin herbaceous stratum from which grass is absent, and which underlies a denser or lighter canopy of thorny scrub. These swamps are fed by shallow seepage glades, often not more than 100 yards in width, descending between the wooded hill spurs, and frequently containing permanent waterholes. The rivers and streams have sandy beds, often cut deeply into the surrounding alluvium, occasionally raised above it, and may flow only half-a-dozen times in the year.

The general aspect of the country seen from the air is of range after range of broken hills, crowned with conspicuous outcrops of piled whitish rocks, and covered with monotonous "miombo" woodland, green in the rains, silver-grey in the dry season; broad sweeps of densely-thicketed rising ground, ridges, or plateaux; and occasional patches of open country, yellow or grey in the dry season, representing the larger seasonal swamps or the sparse cultivations of the natives. The whole is dominated by the magnificent extinct volcano Hanang, rising suddenly from the open Mangati Plains to the north to a height of 11,000 ft. above the sea.

Climate.

This was described provisionally in the account of the Sambala work (1930). The rains last from late November or early December to April or May, with usually a well-marked dry period about February. The dry season includes a cold period from May to July, when minimum temperatures of 40° F. or less may be experienced and the maximum seldom exceeds 80°; and a hotter period from August to November with minimum temperatures of over 50° and maxima up to 90°. In the height of the dry season the relative humidity falls to as low as 20%. In October or November there is usually a preliminary shower of rain. In the rains when the sky is overcast the maximum temperature may not reach 70°. In a year (1931–32) over which observations were taken at Masiliwa by the writer the total rainfall amounted to 23·75″, 2 or 3″ above the average fall as quoted by Obst (1923) for Kondoa-Irangi, Singida, and Sandawe.

In 1929–30 there was about twice the normal rainfall, and the "short dry season" about February was not well-marked.

Vegetation.

The vegetation of the area as a whole differs somewhat from that described as occurring about Sambala (1930).

1. *Berlinia-Brachystegia* woodland ("miombo").

Open, clean-stemmed woodland with dry season visibility up to 200 or 300 yards. There is a poor grass growth on light-grey, dusty soil with frequent small sandy patches and rock outcrops. The dominant trees are *Berlinia globiflora* and *Brachystegia itoliensis*. On the summits of hills occurs *Brachystegia microphylla* ("*Juniperus procera*" in Obst's papers); this species dominates large areas on the Bereku Ridge about Salanga. Smaller trees include *Commiphora pilosa* on ant-heaps and *C. fischeri* in a ring round their bases, and *C. ugogensis* in more thicketed parts. *Terminalia sericea*, *Combretum zeyheri*, *C. splendens*, and sometimes *C. fischeri* occur by the seepage glades, in the transition zones, and in woodland regenerating on old cultivation. In places there is a considerable growth of *Aeschynomene glutinosa*, a smallish, thin-stemmed, many-branched shrub with pinnate leaves. Large areas of the woodland may be thickened up with bushes of *Grewia*, when the visibility may not exceed 50 yards.

The *Berlinia-Brachystegia* woodland as a whole sheds its leaves about July, earlier in Sandawe; trees flush in September about the drainage lines, but the general flushing is at the break of the rains early in December.

The seepage glades running through this type support such small trees as *Lannea humilis*, *Commiphora schimperi*, and *C. subsessilifolia*, and shrubs of *Randia*, *Thunbergia* and *Grewia*; the presence of *Gardenia* and *Thunbergia* may

indicate permanent subsoil water. Larger trees are few and include *Acacia spirocarpa* and *A. nefasia*; the small gall-acacias *A. drepanolobium* and *A. formicarum* may occur in small swampy patches. The white-flowered herb *Hygrophila spinosa* characterises hollows that become small ponds in the rains.

2. Thicket.

(*a*) Thicket on the yellow duricrust in the west.

These thickets tend to occupy the upper parts of gradually rising ground. They differ from the Itigi thickets found to the south-west chiefly in the absence of *Baphia burttii* and *Pseudoprosopis fischeri*; the first species occurs, however, in the extreme south-west of the area. The dominant species is *Bussea massaiensis*, either as a large shrub or as a tree up to 50 ft. in height. The mass of the thicket is composed of *Burttea prunoides*, *Grewia holstii*, and *Combretum trotheae*, with patches of evergreen *Craibia burttii*. The tall tree *Boscia grandiflora* may occur in fairly large numbers scattered through the thicket, and the dark globular tops of *Euphorbia* sp. cf. *ingens* are a characteristic feature.

(*b*) *Commiphora* thicket on red soils in the east.

This formation is less dense and compact than the preceding. *Bussea*, *Burttea*, and *Craibia* are absent, and *Commiphora schimperi*, *C. ugogensis*, and *C. fischeri* common. The mass of the thicket is formed of *Grewia holstii*, *G. platyclada*, *Combretum trotheae*, and the thorny rambler *Acacia pennata*. The small shrub *Abrus schimperi* is common. In this type, as in the last, grass is scarce or absent, and the thicket is almost impervious to fire.

3. Seasonal swamps.

(*a*) Dominated by *Acacia rovumae*.

This type was sufficiently described in the account of the Sambala work (1930). *A. rovumae* is a large thorny tree associated with certain smaller *Acacia* spp. and Capparidaceae, occurring on alluvial soils where the place of grass is taken by the Myrtaceous *Barleria* spp. There may be a dense and extensive substratum of *Acacia drepanolobium*. The country is characterised further by the presence of baobabs (*Adansonia digitata*), and may contain more or less admixture of *Grewia* and other thicket shrubs.

(*b*) Dominated by *Acacia kirkii* and *A. stuhlmannii*.

These are long-thorned, small trees, with many stems diverging from near the base and low spreading canopy. *A. stuhlmannii* affects the heavier soils with more abundant growth of coarse grass. Both species form fairly pure stands where they occur and may cover large areas. *A. kirkii* is found also in country dominated by *A. rovumae*.

(*c*) Open swamps.

Treeless areas usually not over a mile across, bordered by the preceding types and supporting a coarse grass growth on very heavy soils. In the rains the white and purple flowers of *Hibiscus cannabinus* are conspicuous above the grass. Large ponds with *Hygrophila spinosa* persist well into the dry season.

4. Open, undulating plains.

These are confined to the volcanic and alluvial soils in the north, and are scarcely included in the area. The dominant tree is *Acacia seyal*, a tall, often reddish-barked species with long straight thorns usually with whitish galls at their bases. Park-like woodland of *Acacia spirocarpa* and *A. senegal* may occur on rising ground.

The ecological successions of the above vegetational types are not fully understood. Mr. B. D. Burtt, Botanist, Department of Tsetse Research, has

explained to the writer his reasons for assigning relatively small importance to the rôle of fire, and great importance to that of erosion (apart from erosion caused by human agency), in effecting gradual replacement of thicket by " miombo " woodland. Mr. Burtt stresses the sharp adaphic division between the two types; the impermeability not only of the thicket but also of much of the poorer-grassed " miombo " to fire, some localities showing many years' accumulation of unburned logs and twigs; and the fire-resistant sandy strip, where actual erosion is taking place, between thicket and " miombo." It is noteworthy that, in areas where marked hill features are absent, the thicket occupies the low crowns between the shallow drainage valleys, and the " miombo " occupies the space between the thicket and the alluvial soil about these drainage lines. In hilly country the " miombo," as well as lining the drainage valleys, often occupies the exposed tops of the hills and ridges. Further, Mr. Burtt points out that in many areas where grass fires fail to enter the " miombo " year after year there is no sign whatever of incipient regeneration of thicket. Naturally such considerations do not apply to better-grassed " miombo " in which fiercer grass fires can occur; but in the region of the great thickets of Central Tanganyika such longer-grassed woodland is not found.

Erosion also appears to cause transformation of " miombo " woodland into the various *Acacia* communities growing on alluvial soils. On these soils the growth of thicket elements on ant-heaps and similar situations is probably checked by fire when the grass growth is sufficiently long. The type of community found seems to depend on the extent to which the soil is water-logged during the rains, the better-drained soils carrying *Acacia rovumae* and its associated flora.

Thus Mr. Burtt regards the main process of ecological succession as one of gradual erosion of the yellow, cement-like thicket soils to expose the granitic substratum on which thicket can never regenerate and on which " miombo " woodland appears. Where thicket is cleared and erosion does not occur, thicket and not " miombo " will grow up.

The Game Animals.

This is pre-eminently the country of rhinoceros, buffalo, elephant and giraffe, which are common throughout the area. Eland and zebra also are found throughout. In the west the commonest large antelope is the greater kudu; in the east and north-east its place is taken by roan antelope and Coke's hartebeest or kongoni. Waterbuck are confined to the neighbourhood of Selya near the Bubu.

Among smaller antelopes, the lesser kudu and pygmy antelope or suni are found about Swagaswaga hill in the centre of the area, in country characterised by much thicket and *Acacia rovumae*. Bushbuck occur about Sambala and the country between the Bubu and the southern part of the Mekenke valley, reedbuck are scattered throughout. Steinbuck are found on most of the open swamps, klip-springers on most rocky hills. Dikdik and common duiker are numerous and ubiquitous. Impala occur about the Mekenke valley and west of Selya, and about Ma'anguro in the north-east.

The game of the Mangati Plains to the north includes Grant's and Thomson's gazelles, impala, steinbuck, wildebeest, ostrich, zebra, eland, roan antelope, Coke's hartebeest and giraffe.

Ostrich are found on flats about Sambala and the Mekenke valley. Warthog are numerous throughout the area, and bush-pig are common wherever there is thicket.

Population.

Along the Bubu river there are numerous cultivations of the Werangi tribe, and of the Wasi farther north. In the west are settlements of the Wanyaturu, straggling out as small outposts from the main Singida cultivation steppe above the Rift Wall. The Mangati (Barabaig) formerly inhabited much of the area until driven out by the tsetse. They now inhabit the open plains about Hanang. These people are essentially cattle keepers and scarcely till the soil.

The most important tribe in the area is the Sandawe, a pre-Bantu people speaking with clicks. They inhabit the south of the area from the Bubu to the Rift Valley, but small settlements remain in the fly-infested bush up to within a few miles of the Kondoa–Singida motor road traversing the area from east to west. They are famed as honey-hunters. These people formerly lived in a state of constant friction and hostility with the Mangati to the north, until the advancing tsetse came like a wedge to force the two tribes apart, and to provide one more curious aspect for the student of the ecology of this fly.

All these tribes keep cattle, and with the exception of the Mangati all till the soil.

Human sleeping sickness does not yet occur in the area, the prevalent trypanosome being *T. congolense.*

Note on the Map.

The map was constructed from over 1,000 bearings obtained with a prismatic compass. While it is realised that such a method can aim at no high standard of accuracy, a list of bearings taken in both directions shows that disturbance due to local magnetic influence was not very great. This fact made it possible to discount to some extent bearings taken from points found to show important discrepancies, and from most of the remainder very good resections were obtained.

The name "Thamba" has appeared as "Samba" in an earlier paper (1930).

III. The History of the Advance.

The history of the fly advance has been reconstructed from several sources, including German and British records, and native information collected by the writer and by Mr. W. H. Potts, Senior Entomologist, Department of Tsetse Research; while surveys carried out by various members of the Tsetse Research Department have supplied information on the recent encroachments and present boundary of the fly.

Distribution of Tsetse in the Distant Past.

From the account which is given below, it will be evident that a real advance of tsetse has taken place and that the fly has not merely been making its presence felt through an increase in density of an indigenous infestation within recent years. But the possibility is not precluded that the whole of this country may have been infested at some time in the far-distant past, perhaps a thousand years ago, with a fly-belt which for some reason became extinct.

Thus, before the present fly-belt came into being, the belt of *G. morsitans* in eastern Kondoa at the edge of the Masai Steppe, and the isolated belt about Lake Manyara to the north of it, must have been separated by a distance of 150 miles from the great belt of this species which occupies western Tanganyika, and by a similar distance from the great eastern belt about Handeni. As the

eastern Kondoa and Manyara belts could not have arisen spontaneously, it seems that they must have been connected at some time with either one or the other of the great eastern and western belts.

The present position is that the advance under consideration represents one of two converging encroachments of fly, the first moving south-westwards from eastern Kondoa, and the second north-eastwards from the great western fly-belt, which has thus advanced in recent years to a point less than 30 miles from the town of Singida. At the time of writing it seems that the two advances are destined to meet on the top of the Rift Wall about Mau.

This condition suggests that the great western and the eastern Kondoa fly-belts are perhaps effecting a re-union after a separation of centuries. That the separation has been a long one is suggested by the absence of any native tradition of a former infestation of tsetse in the intervening area, and, very significantly, by the absence in the Sandawe language of any word for tsetse-fly. The Sandawe are supposed to be the aboriginal tribe of the area, and use for tsetse the Swahili word *ndorobo*.

A third, isolated fly-belt (the " Hika fly ") is also advancing towards the Mau hills from the south; but this belt would not appear to represent a remnant of a formerly continuous infestation, since according to Mr. B. D. Burtt, Botanist, Department of Tsetse Research, it would appear to owe its origin to the construction of the Central Railway just before the War, flies being brought on trains from the great western belt to start a colony about Saranda.

If the great western and the eastern Kondoa fly-belts *were* at one time continuous, it is not proposed now to hazard any guesses as to the cause of the abandonment of the intervening country by the fly.

Fly on the Upper Bubu River.

The origin of the present fly advance was undoubtedly a colony of tsetse about Berabera on the upper part of the Bubu river, where there is very thick fly to-day. The writer's own view is that this colony arose from flies crossing the Wasi hills from the eastern Kondoa fly-belt about Kandaga on the edge of the Masai Steppe. In 1927–28, Mr. Potts and the writer found fly scattered thinly through the broad, shallow drainage valleys in these hills, from Salanga to the Bubu, although they were so scarce as hardly to affect the numerous herds of Wasi cattle grazing there. The writer also investigated the propensity of flies to follow parties of men ascending the escarpment above Kandaga: flies were readily carried to the top.

Fly seems to have been on the upper Bubu river since before the War. Mr. R. L. L. Hart, Deputy Director of Veterinary Services, Uganda, told the writer that troops advancing on Kondoa-Irangi from the direction of Hanang Mountain during 1916 sent their animals through the upper Bubu country by night in order to minimise loss from fly.

Obst (*loc. cit.*, 1915, p. 67), who passed through from Salanga to the Bubu in December 1911, notes that the Mangati tribe then kept their cattle in these hills, and that their good condition argued good pasturage. On the other hand (1923, p. 279) he states that especially great losses from fly occurred among the cattle of this Tribe, whom he here calls the Tatoga. As he could have encountered fly in the country occupied by the Mangati only between Salanga and the Mangati Plains, it would appear that the losses referred to occurred about the upper Bubu. The writer has been unable to obtain the papers by the travellers Glauning, Hudemann, Lademann, and Pfund, who passed through this region in German times.

Elsewhere (1923, p. 273) Obst states in general terms that "the tsetse-fly threatens at least in places the herds of Umbugwe-Iraku [north and north-east of Hanang Mountain] as far as Ugogo below [south of the Sandawe country], from the Masai Steppe in the east as far as Turu, Issansu, and Iramba in the west." As far as the last two areas are concerned, as well as Iraku (Mbulu), the threat is from *G. swynnertoni* and not *G. morsitans*. He gives no account of the tsetse distribution, referring the reader to a map published in "Die deutschen Schutzgebiete in Afrika und der Südsee, 1912–13." But no tsetse are shown in this map nearer than the Manyara fly-belt well to the north of the fly in eastern Kondoa, whereas Obst himself notes that at Kikori (in eastern Kondoa) cattle keeping is impossible, "owing to the particularly bad tsetse infestation here." (Obst, 1915, p. 54.) The absence of any tsetse area about the upper Bubu on this map cannot, therefore, be taken as proof that none existed. In this publication tsetse did not in fact appear to receive much attention, since the sole reference to it (p. 38) is as follows: "Tsetse has remained in general within its earlier boundaries. Great losses among the standing stock are not therefore to be reported. Losses among cattle in transport are considerably reduced owing to forwarding of stock by rail and most probably to going round outside the tsetse areas. The tsetse map was further added to."

Werther, the original conqueror of Hanang, traversed the upper Bubu region before the end of the last century on his return from Hanang to Kondoa-Irangi. He passed through in a violent rainstorm and does not mention the presence of fly. He states that the pack animals were sent on ahead, but does not state by which route.

This is the whole of the evidence which the writer has been able to obtain as to the date of origin of the fly-belt on the upper Bubu. It appears probable that fly climbed the scarp above Kandaga, spread through the Wasi hills (here called the Bereku Ridge), and established themselves at some time between the beginning of the century and the start of the Great War about Berabera on the upper Bubu river.

The Advance Westwards North of the Kondoa-Singida Road to Sambala.

This part of the area was entirely unexplored by the German writers, and is characterised by Obst as "still quite unknown." Mr. Potts visited early in 1928 the villages of Sambala, Lankasese, and Seja's, and subsequently the writer carried out numerous reconnaissances from Sambala to Berabera and the Mangati Plains. Information on areas formerly fly-free is obtainable from the disposition of the numerous abandoned settlements of the Mangati tribe. As this tribe depend for their livelihood on their cattle, their prolonged presence in any area is sufficient proof that tsetse did not occur there at that time. The writer was shown abandoned settlements of these people at Ma'anguro, Kunti, and from Sambala to the Mangati Plains. He was told that an old man called Mahanja, now living at Sambala, formerly lived and kept cattle at Metanganimu, west of the Bubu and a few miles south of Berabera; that he retired before the advancing fly to Kunti, and subsequently from there to Sambala. On the writer's arrival in Sambala early in 1928, he still had two animals left alive, and these were grazed in the then scarce-fly area south-east of that place. They subsequently died. His son, Hagire, now living at Lankasese, informed Mr. Potts that cattle were still kept at Kunti at the beginning of the War. In 1916 Mangati raids caused him to leave and to spend one year in Irangi; on his return to Kunti he kept cattle there again for a season; there they died, and

he moved to Lankasese, where fly were present already in small numbers, and where he had the impression that they arrived earlier than at Kunti. At this time (probably about 1917–18) fly had not reached Sambala.

An old Sandawe called Songita, now living at Husa, informed Mr. Potts that he kept cattle in Sambala until the War, but that the cattle of a Mrangi (probably a man called Kawa) died there on his coming to settle at Sambala in the year of the "Ufiome famine," 1919.

Thus fly would appear to have reached Sambala about 1919; it must have spread rapidly from Kunti in the preceding five years, or alternatively it must have first outflanked that place and invaded Lankasese to the south, reaching Kunti a year or two later. In support of the second suggestion, the writer was shown in 1928 abandoned Mangati settlements at Ma'anguro, north-east of Kunti, which he was assured had not been evacuated many years.

The Further Advance in the North-West.

For data on the advance west of Sambala the writer is indebted to Mr. H. N. Ruhl, Stock Inspector, Singida.

About 1923, some fly-struck cattle were found by him in two herds moved from Manyalu (or Munyala) to Dara, then the permanent home of the Mangati chief Akidapanda. Although these cattle might have become fly-struck while grazing to the east of Manyalu, it is probably about right to suggest 1923 as the date when fly reached there.

Farther west, at Umu, the Mangati drove out the present inhabitants of Masiliwa following a quarrel over salt at Balangida in 1918. The Mangati continued to live in Umu until 1927, or 1928 when they were driven out by fly.

The history of the fly on the road south of Umu, from the settlements of Masiliwa to the Malulu river, the boundary of Kondoa and Singida Districts, is of great interest. From 1921 to 1925 this section of the road was used as a rinderpest quarantine area by Mr. Ruhl for cattle proceeding along the road from Singida to Kondoa, and all cattle passing through were detained here for at least a fortnight. Difficulty was experienced in preventing contact with the Mangati cattle at Umu. The road here and Umu were thus free of fly at that time.

On the 8th September 1927 Mr. Potts, passing along the road by car from west to east, took a few fly between Masiliwa and the Malulu river. On the 5th October 1928 the writer, going by car from Kisima cha Mungu hill to Masiliwa, saw no fly from Kisima cha Mungu to the Malulu river, and then took six individuals between there and Masiliwa. Mr. Ruhl, who took two flies on this section of the road in 1928, states that fly were already thick on the Malulu river north of the road. Evidently fly did not spread along the road from points crossed earlier to the east (see below), but first invaded the country west of Sambala, and then descended on the road from the north.

About Masiliwa in 1931, the writer was shown abandoned Mangati villages, within the crescent of the Mnangana thicket north of Masiliwa, and north of that thicket about Itolohonya and Buhama, which were said to have been abandoned the year before.

The Advance South of the Kondoa-Singida Road.

According to information obtained by Mr. Potts from an intelligent native clerk employed first by the Germans and then by the English in Kondoa-Irangi, fly were found on the Singida road as early as 1908 between Swagaswaga and the Mkola hills. The writer is inclined to discredit this statement, as that

stretch of the road has never had many fly on it, the country being for the most part unsuitable for them. As late as 1928 fly were very scarce there indeed, whereas they were common farther east, and found, as described above, west of the Malulu river. Moreover, if fly did not arrive at Sambala until about 1919, it is most unlikely that they reached the road to the south-west of that place over ten years before. The same man said that fly reached a lake near the Bubu a mile or two north of the road in 1908, and that the subsequent deaths of Government cattle caused the Germans to make a clearing there. On the other hand he said that fly did not reach the settlements of Cha-Nga, several miles farther north, until the War. This seems rather improbable.

Mr. Ruhl, passing along the road from Singida to Kondoa at Christmas, 1922, took one fly, and saw and heard either one or two more, in the Dume valley east of Swagaswaga hill. He states, however, that fly were already known to occur on the road between Mongoloma and the Bubu (*i.e.* about Selya) at that time.

The Hon. F. W. Bampfylde, formerly Acting District Officer, Kondoa-Irangi, told Mr. Potts that odd flies occurred on the Saranda road a few miles west of the Bubu river in 1920, but that they were not in sufficient density to prevent the use of ox transport there. The native clerk referred to above gave 1913 as the date of arrival of fly at Matonya, a long way farther down the Saranda road, but stated that they arrived at Simbo on this road only during the War, driving out the returning natives who had left there with their cattle during the campaign. This again seems unlikely, although the date given for the arrival of fly at Simbo is probably about correct.

According to other native information supplied to Mr. Potts, an old Sandawe moving into the present settlement of Kunuse, north-west of Simbo, found fly present in small numbers in the year of the famine, 1919.

In 1926 Messrs. Potts and Burtt started investigations in this part of the area. They found heavy concentration of fly about Selya and on the Saranda road, and the southern boundary had been carried forward as far as Tsantsai village and Githlau hill, but not to the villages of Songa and Klankase. The Director of Tsetse Research instituted clearing measures followed by settlement at Selya, and reduced the numbers of tsetse to the west of that area by other means. This work was continued at intervals up to October 1928.

In October 1928 Captain V. A. C. Findlay, Field Experiment Officer, Department of Tsetse Research, carried out a survey of the fly boundary south of the Kondoa-Singida road. Dr. T. A. M. Nash, Entomologist, Department of Tsetse Research, had also made certain observations in the Jogose valley area in 1927–28; other reconnaissances were carried out by Mr. Potts there about the same time, and the writer made more detailed observations about the head of the advance in the Jogose-Rungurunguse-Kirambo-Mataku-Kiguru area in 1928.

From this work the fly boundary south of the Kondoa-Singida road in 1928 was determined to be as follows: From a point on the road a little east of Masiliwa south to the settlements of Mpumbu; thence curving back north-west of Handa and north of the Mkola hills (except one fly found by Captain Findlay south of Mkola) to a point just west of Kisima cha Mungu hill on the road; thence south along the east edge of the Buko thickets, and west along their south side to the village of Mataku; thence south-east to the village of Thlawa, and thereafter south-east along the present boundary through Klankase, Songa, and Donse villages to the unsuitable *Acacia* woodland stretching to the Bubu river. This woodland checks further advance to the eastward as far as the

confluence of the Bubu and Mekenke rivers, north of which point the east bank of the Bubu is guarded by close settlements against further encroachment of the fly.

Cattle were kept at Rungurunguse up to 1927, and in Kiguru to the west up to 1928. Cattle are still kept at Songa, where fly is still very scarce, and were kept at Amathle until a few years ago.

The Present Fly Boundary.

In 1931–32 the writer carried out further surveys which provide the most recent data on the progress of the fly-belt. As before, the fly boundary followed the edge of the Mangati Plains in the north, but odd flies were taken as far as Balangida salt flat in the Rift Valley, and flies were taken in some numbers north of the Mnangana thicket to Buhama hill. Within the crescent of this thicket they occurred in small numbers west of Masiliwa, and in very large numbers to the east of that village. (Over 18,000 live puparia were collected in one week by 50 natives between Masiliwa and the Malulu river in August 1932.) South of the Mnangana thicket fly had spread west as far as the village of Mugunga and the Mpogo swamp south of Buo hill. Their southward progress was checked by the Kinyampembe and Kutsuwa thickets, but salients were thrust out through gaps in the thickets towards Ilambase village, from Muporu to the Hanse swamp, and along the river south-east of the village of Duwa Mganga. East from here, the fly boundary encircled the settlements of Handa and Maji-Malulu, where cattle were lost, and Thlawa, from which place the boundary was the same as that found by Captain Findlay in 1928.

Examples of the Great Increases in Fly Density During the Advance.

The great increase in fly density on the road from Masiliwa to the Malulu river has been remarked above. In other places striking increases also occurred, some examples of which are given below.

Path from Mataku village to Kopase village.
31.5.28, 1 fly and 1 seen. None on return journey.
6.12.31, 48 flies. (1 journey.)

Path from Mataku village to Kiguru village.
6.9.28, 1 fly, near Mataku. None on outward journey.
3.12.31, 19 flies. (1 journey.)

Path from Kiguru village to Maji-Malulu village.
6.9.28, none. (2 journeys.)
3.12.31, 30 flies. (1 journey.)

Jogose-Thamba-Kindowa-Kirambo area.
Fly about 10 times as abundant in December 1931 and May 1932 as from December 1927 to October 1928.

From April to October 1928 the writer observed by regular fly rounds the spread of the fly westwards in the Rungurunguse-Mataku-Kirambo valley area, all of which had remained practically or completely fly-free until after the rounds were begun. Similarly over a series of visits the spread of fly was observed from Munge hill and Muporu village to the Hanse swamp to the south.

General.

From the above detailed evidence there can be no doubt that a spread of fly has occurred from some point in the north-east of the area, probably mainly

or entirely in the present century, and that this spread has continued to a depth of some 50 miles. It is impossible to suppose that fly has been present in the area all the time, perhaps patchily, and has merely increased in density and continuity of distribution within recent years.

The general direction of the advance has been south-westwards, but there has been also an advance northwards from Berabera on the Bubu. The writer has not surveyed this country. He was told by a native that the northward advance from Berabera was checked by settlements at Chemai (not shown on the map). The boundaries of this northward advance have not been determined, nor is it known whether the advance in this region is still continuing.

As to the advance of the great western Tanganyika belt into south-west Singida District, the writer has information on the stages of this advance from Mr. Ruhl, but it is not proposed to include an account of it in the present paper.

IV. Factors Favouring or Retarding the Advance.

Climatic Factors.

Consideration of the recent history of the advance shows that it must have been particularly rapid in the three years from 1928 to 1931. Questioning of numerous natives in the lately-infested areas has produced the statement that marked increase and advance of fly took place following on the abnormally heavy rains of 1929–30. Visits to the eastern parts of the area in October 1930 confirmed this view. This is of some interest, since following on the heavy rains of that year Dr. Nash and other workers in the low-lying eastern Kondoa fly-belt bordering the Masai Steppe had noticed a great reduction in numbers of fly, together with a withdrawal of tsetse from the extreme south end of this fly-belt. Mr. Potts has suggested that the two fly-belts may represent respectively the dry-country and wet-country limits of distribution of *G. morsitans*, and that a very wet year might therefore benefit the one and tend to destroy the other. From instrumental readings it is known that the western Kondoa-eastern Singida fly-belt occupies in fact drier country than that in eastern Kondoa.

Vegetational Factors.

Although, as will be seen in the next section, it would appear that the flies in the van prefer to follow the drainage lines, which implies that the presence of numerous small valleys running in the right direction might tend to favour rapid advance, it would appear that wherever suitable " miombo " woodland occurs the advance will continue. If the " miombo " is rendered more dense by discontinuous thicket, it seems less favourable as a fly habitat, especially in the rains when the thicket is in leaf. This is apparent from the following fly figures obtained near Masiliwa in 1931–32.

Type of " miombo."	Length in yards.	Mid dry season. 25 days.		Rains and early dry season. 38 days.	
		Total.	Fly per day-yard.	Total.	Fly per day-yard.
More open . .	1,200	584	·0195	878	·0193
More thicketed .	400	86	·0086	89	·0058

These figures show that in the dry season, when the trees and thicket

shrubs are leafless or nearly leafless, flies are more than twice as common in the more open as in the more thicketed woodland; but that in the leafy season they are more than three times as common in the first type as they are in the second. Similar cases were noticed in the Jogose-Thamba-Kindowa-Rungurunguse area. The presence of much *Aeschynomene glutinosa* in the " miombo " woodland is believed to have a similar effect.

" Miombo " regrowing on old cultivation seems in this area relatively unfavourable so long as the trees remain under about 30 ft. in height. This has been noticed also in Kahama District, at Kazikazi in Manyoni District, and in northern Nzega District. In the last-named area fly seemed to be practically absent from regrowing " miombo " woodland, while it was common in woodland of *Terminalia*—other species growing alongside.

Dense, continuous thicket, either in the dry season (when it is leafless) or in the wet, appears, in sufficient width, to act as an absolute barrier to *G. morsitans*. From Mr. Burtt's work at Kazikazi it would seem that less width will suffice in the wet season than in the dry. Well-defined paths through the thicket, whether of man or of elephants, greatly reduce the efficiency of the barrier, as of course do small islands of " miombo " scattered through it. In the country under consideration such small islands are rather common where the country is hilly. Possibly a mile width of continuous thicket not pierced by paths may prove an effective barrier to *G. morsitans*.

About Sambala in 1928–29 it was noticed that in large areas of *Acacia rovumae* bush and *A. kirkii* fly was exceedingly scarce. Such an area occurred immediately south of Sambala and stretched from the open swamp of Nafimu north-east of Swagaswaga hill to some miles north-west of Kisima cha Mungu hill on the Kondoa-Singida road. Consequently there was a long delay before the " miombo " woodland west of Kisima cha Mungu became infested by fly.

A similar area is found in the Mekenke valley. Lower down, this valley is some 6 miles broad and at present practically fly-free. Higher up, at Handa, the valley is only about 2 miles across, but keeps remarkably free of fly, so that cattle are still kept at Handa in some numbers, although losses occur.

The open Mangati Plains are of course fly-free outside a few miles from the limit of the " miombo " woodland.

The Game Factor.

From what has been said above it is evident that game, the food of the fly, is common throughout the area. As there is no question of wholesale migrations of the animals to and fro, they can have very little effect in assisting or retarding the advance. Moreover, from experiments described elsewhere it is known that flies will travel independently upwards of a mile in a few hours; and, since the rate of advance of a fly-belt is only 2 or 3 miles a year, the rôle of the game in carrying flies into uninfested country into which they would otherwise wander unaided must be quite negligible.

The importance of the game might lie in carrying the fly across some barrier through which it would be unwilling to venture of its own accord.

From work described elsewhere there is no question that, in this area, game is at all seasons more than sufficiently abundant to feed the fly.

The Population Factor.

While small villages (*e.g.* Lankasese) are often associated with a very dense tsetse population, it usually happens that fly is rather scarce about larger settlements, such as Masiliwa and the settlements along the east side of the

Bubu valley. The writer does not believe that this is by any means entirely due to disturbance of the game animals in the neighbourhood of large settlements or to alteration of the surrounding woodland, and considers that more work on this problem is necessary before a satisfactory explanation can be found. Meanwhile it is worth remembering that a settled barrier backed by thicket may perhaps be the best of all practicable defences against the advance of fly.

Roads.

It has already been noticed that the fly advance crossed the Kondoa-Singida road at three points, and did not proceed along it. As with the game animals, it would not seem that a road assists the fly advance unless it crosses some barrier unfavourable to the fly.

It is interesting that flies are continually being carried through the Mnangana thicket on lorries and cars passing along the Kondoa-Singida road. They are picked up in very large numbers (hundreds at a time) on the road east of Masiliwa, and have been carried as far as Mgori's village in the Rift Valley, 10 miles west of the thicket. Yet fly has not yet established itself anywhere in the apparently suitable country west of the Mnangana thicket, and cattle in the settlement of Lamba remain healthy. At the same time, fly are advancing round the north and south flanks of this thicket, and the invasion of the Lamba area must, it seems, be only a matter of time.

Topography and Altitude.

From the observed tendency of flies to be carried up the escarpment above Kandaga on the edge of the Masai Steppe, and from the fact that this fly-belt appears to have originated in this way, it is not likely that the gently-sloping scarp of the Rift Wall about Mau will prove any obstacle to the advancing tsetse when it arrives there. The altitude of the Rift Wall there is only some 5,000 ft., a height not likely to prove a deterrent, since at Itolohonya north of Masiliwa fly is already established at 5,300 ft. This is about the highest infested point in the fly-belt, but not necessarily the highest possible altitude for *G. morsitans*.

V. The Mechanism of the Advance.

Several thousand flies have been marked and released in the course of experiments directed to throw light on the destiny of the most advanced flies, but so far without any definite result. However, it would appear that the advanced flies show a preference for the drainage lines.

Under normal conditions, as described elsewhere (1930, *loc. cit.*, and 1933, *Bull. Ent. Res.*, **24**: 453), the hungrier flies, including females and all young flies which have not yet had their first meal, are to be found mainly in the drainage valleys, the repleter flies in the "miombo" woodland. Except in certain special sites, the apparent density of flies in the drainage valleys is not much if at all greater than in the surrounding "miombo." But where fly is scarce, as at the fringe of an advancing fly-belt, it seems that flies are relatively numerous in the drainage valleys and scarce in the "miombo" between them; moreover flies are not hungrier in the drainage valleys than in the "miombo."

Thus from a number of extensive reconnaissances carried out in scarce-fly areas north and south of Masiliwa in 1931–32, the apparent density of fly in the drainage valleys was about four times as great as that in the "miombo"

woodland, where flies appeared equally hungry. There were indications also that in the Jogose-Thamba-Kindowa-Rungurunguse area in 1928 a similar condition obtained, while in 1931–32, in association with the great increase in fly which had occurred in that area in the meanwhile, the normal distribution, with hungry flies in the valleys and normal infestation of the " miombo " woodland, had been assumed. The matter was complicated, however, by the thicketed character of much of the " miombo " in that area, and by the fact that the sections of the fly-rounds marked out in 1928 were not very suitable for observing this change.

In 9 days' observations made from November to February, a fly round carried out at Masiliwa showed a total of 78 flies in a narrow drainage valley on a transect 1 mile in length, and 15 only on a transect of equal length in the " miombo " woodland alongside. The percentage of females was 13 in the " miombo " and 23 in the valley; but an analysis of the hunger condition of the mature male flies from the two transects showed that those from the valley were scarcely hungrier than those from the " miombo." This is a fair instance of the " scarce-fly " type of distribution commonly observed about the head of the fly advance.

If on the author's return to the Masiliwa area, fly has increased in density about this and similar valleys and is relatively more numerous in the " miombo " and more hungry in the valleys than when the above observations were made, then the view that the fly distribution noticed there in 1931–32 represents only an early phase of the fly advance will receive some support. At present this view is only a hypothesis. Should it be confirmed, it may be supposed that it would indicate some social instinct in the tsetse while occupying country where its numbers are still low, the drainage valleys serving as rallying points for the thinly-scattered vanguard of the advance. In support of this supposition, the writer seems to have noticed a similar condition in parts of Nzega District, where, although no fly advance is taking place, the apparent density of *G. morsitans* is low.

Apart from this question of social concentrations in the valleys, the advance may be supposed to proceed somewhat as follows. From the dense fly population behind, where breeding occurs, flies are continually wandering forward to a depth of several miles in accordance with what is known of the independent movements of tsetse-flies. (One fly marked near Masiliwa was recaught in the Kitala hills, 20 miles to the south-east; and two flies marked near Masiliwa were caught at Duwa Mganga, 8 miles to the south.) Among these wandering flies composing the advanced fringe of the belt, perhaps to a depth of six miles, a great number probably die without breeding there, the flies being too thinly scattered for many meetings between the sexes to occur. Thus it is the increase of the main body and not the " scouts " ahead which in the main determines the speed of the advance. But although the advance proceeds through increase in numbers of the main body, there is no effect of pressure of population causing congestion and therefore migration, because the increase of a blood-sucking insect feeding on hosts tolerant to its attacks is not, within wide limits, dependent on the food supply. It is practically true to say that a population of host animals sufficient, in any area, to support a population of a few tsetse is sufficient to support any number.

It may be taken as fairly certain that the flies in the van of the advance feel no " impulse " to fly ahead. On the contrary, it is possible, although the writer has not succeeded in demonstrating it, that they may have some social instinct causing them to break back towards the denser fly population behind.

If such an instinct exists, it might account for the slow rate of progress of the advance, which is one of its more puzzling features. It is hoped that it may be possible to pay more attention to these matters in the future.

VI. The Future of the Advance.

The arrows on the map indicate the directions which, in the author's view, the advance is likely to take in the next few years.

No advance is possible in the north of the area across the Mangati Plains, and the unsuitable woodland on the Rift Wall west of Balangida precludes advance there also.

Fly is likely to occupy before long all the "miombo" woodland between the Mnangana thicket and the Rift Valley, as it has already outflanked this thicket at both north and south ends. The woodland appears suitable for tsetse, but the western aspect of this country, sloping to the Rift Valley, implies more severely arid conditions in the dry season than, perhaps, anywhere in this fly-belt.

South of the Buo thicket, fly will advance from the Mpogo swamp to the "miombo" woodland in the Rift Valley to the north-west, and south-west through the "miombo" to the Rift Wall about Mau. These advances are unlikely to be rapid, as the fly, in order to reach the Mpogo swamp, has to pass through a bottle-neck between thickets, and it will take a long time before a small population about Mpogo can colonise the large area of suitable woodland ahead of it.

A rapid advance on the settlements of Ilambase to the south is likely, as the drainage valleys run in the direction of this advance. From Ilambase the advance will continue rapidly westwards towards the Rift Wall at Mau, and to the limit of the "miombo" in the Rift Valley farther south. South-east from Ilambase there is nothing to stop the indefinite continuance of the advance into the heart of the Sandawe country, and this process also is likely to be rapid. It seems probable that the advance will continue through Sandawe into the Ugogo country to the south and south-east for a distance of anything up to a hundred miles.

From the Hanse swamp south of Muporu, fly will move south to join with others coming south-east from Ilambase, and south-east along the "miombo"—lined valleys intersecting the thicket-blocks south of the great Kutsuwa thicket. Once past these thicket-blocks, through which progress will be slow, fly will advance rapidly towards the southern Sandawe hills, to join with those advancing from farther west.

Above the Rift Wall, flies that have arrived at Mau from the east will join with the "Hika" fly-belt advancing from the south, and probably with the salient of the great western Tanganyika belt now advancing on Singida from the south-west. From there, the combined fly-belts will turn north on Singida, which flies from the south-west will already have encircled on the north-west side.

The author thinks that flies are unlikely to cross the Mekenke valley south of Maji-Malulu, but opposite this place it is just possible that some may get across into "miombo" woodland south-west, to join with others advancing from the west on the southern Sandawe hills.

The prospect is thus one of economic ruin for the Sandawe and Turu tribes, and the Burungi and Gogo tribes respectively south-east and south of the Sandawe may be affected also.

VII. Summary.

1. An advance of tsetse-flies (*Glossina morsitans*) has taken place in Kondoa, Mbulu, and Singida Districts of the Central Province of Tanganyika Territory, to a maximum depth of about 50 miles from its origin in northern Kondoa.

2. The situation, character, climate, vegetation, fauna, and population of the country are described. A map of the country, including parts previously unexplored, has been made.

3. From a detailed account of the stages of the advance so far as they are known, it is clear that a real advance has occurred, and that the grave state of affairs now obtaining is not due to a mere increase of density of an indigenous tsetse population.

4. Factors influencing the rate of the advance are discussed. Wet years in dry country such as that under consideration may favour the increase of fly. Suitable "miombo" woodland implies that the advance will continue more or less rapidly; more thicketed or stunted "miombo" is less favourable. Dense, continuous thicket is an absolute barrier where it occurs in sufficient width. Certain types of thorn woodland, if extensive, delay the advance, and may stop it. The movements of animals, and the presence of motor roads, do not appear to have any effect on the advance as long as it is continuing through suitable country. The presence of large settlements is associated with a lower apparent density of tsetse in their neighbourhood. Dense, continuous settlement is a barrier to fly.

5. It would appear, but is not proved, that flies when still in small numbers tend to keep to the drainage valleys which under other conditions are used purely as feeding grounds. It is suggested that they may do this for social reasons. The progress of the advance is thought to depend mainly on the increase of population of tsetse behind; this is because a larger population will provide a larger number of flies wandering ahead of their own accord, not because there is any congestion behind. It was not determined whether the most advanced flies have any tendency to return to the main body.

6. The advance is likely to continue southwards and westwards, and to join in the west with two other advances approaching from different directions on Singida. The cattle of several native tribes are likely to suffer heavy losses or perhaps to be exterminated.

ABNORMAL LARVAE OF *AMATHES* (*ORTHOSIA*) *MACILENTA*, HB. (LEP.)

By C. N. Hawkins.

[Read 4th October, 1933.]

With Plates XX–XXII.

In the course of a paper published in 1929 Dr. E. A. Cockayne said with reference to the causes of errors of segmentation : " It seems probable that most of the abnormalities of this kind taken at large are not inherited and must be due to some external cause acting on the ovum at the very early period when the somites are being formed."

The facts stated below appear not only to go a long way towards confirming this view but also to suggest that duplicated limbs, extra wings, and setal and pigmentary abnormalities may, in some cases, be produced in the same way and at the same period. They also suggest that the " external cause " may be a purely mechanical one acting, either directly through injury to the ovum and embryo, or perhaps indirectly through some " shock " effect.

Several of the abnormalities described in this paper are, I believe, unique amongst Lepidoptera, and they derive added interest from the facts that the larvae in which they occurred were bred *ab ovo* and that the circumstance which is suggested as the cause of the abnormalities is known and is not itself a matter of surmise.

Before proceeding to describe these abnormal larvae, however, it is necessary to give some account of their origin and life-history.

In October 1929 at Box Hill I took four female imagines of *Amathes* (*Orthosia*) *macilenta*, Hb. which I decided to keep for ova in order to obtain a few larvae to preserve. I sleeved the moths over some cut twigs of oak placed in water and supplied them with moistened sugar as food. Two of the moths died without laying, but of the other two, one laid, during a period of several days, a large number of ova mostly on the sleeve ; while the other, judging from the somewhat reduced size of its abdomen, also laid a certain number, but not its full complement, before it died. The ova were laid at the end of October and were left *in situ* throughout the winter. Towards the end of February 1930 I noticed that some of them showed very decided signs of development (change to lead colour and, in a few cases, traces of enclosed larva), so I removed them all from the sleeve to a glass-topped metal box. As many of the ova were laid separately, this involved cutting or tearing out the thread upon which each ovum was laid, and as a result a few were destroyed while others were slightly dented. At this time the ova evidently differed considerably in their stages of development as a few changed colour at intervals after removal over a period of two or three weeks. A few ova were apparently infertile and did not change colour. The young larvae began to hatch on the 25th of February, and hatching continued for about a month. Owing to lack of other food, the young larvae were supplied at first with pieces of *Calluna vulgaris*, a reputed food-plant. A good many of

them died, but whether through inability to feed or on account of the unsuitability of the food, I cannot say. However, a considerable number of the larvae managed to survive on the *Calluna* and were later placed on a diet of *Crataegus oxyacantha* upon which they fed and grew well. After a time (I think some of the larger larvae were then in their third stadium, but so far I had not taken any great trouble over them), I noticed, when changing food one day, a larva which looked a little peculiar and which seemed to move rather awkwardly. On examining it I found it had spiral segmentation. I then, and at intervals later, closely inspected the remainder, with the result that I found no less than fourteen larvae with abnormalities of one kind or another. At this stage I had about 130 larvae, but some were still very small and tucked away in leaf-buds, etc., so that I may have overlooked one or two. I separated the abnormal larvae from the others and preserved them in due course, but unfortunately one, a case of a half-somite, was killed, while still quite small, by one of the larger larvae, and seven others died, apparently from some disease which attacked and destroyed many of the normal larvae also. For this reason some of them had not reached their last stadium when preserved, while others were not quite full grown, so that the drawings differ in size, although all are under a magnification of 8 diameters. A normal larva of this species is of a dull purplish-brown colour, becoming darker on the dorsum and very much lighter beneath. The pattern, so far as it is material for the purposes of this paper, consists of a narrow medio-dorsal, creamy-white line expanding into a fusiform blotch on the posterior portion of each abdominal somite, and indications, more definite in some specimens than in others, of a narrow, whitish, subdorsal line not shown in most of the drawings. There are also narrow, transverse, whitish lines as shown in the drawings, probably indicating subsegmental divisions. The setae are placed in whitish circular spots, but in the drawings these spots have been outlined in black and the setae (as also the spiracles) exaggerated for the sake of distinctness. In most cases, reference to the plates will give a better idea of the arrangement of pattern and setae on the abnormal larvae than a detailed description could do.

As already mentioned, one abnormal larva was unfortunately destroyed, but brief descriptions of the remaining 13 are given below :—

1. A larva with double meta-thoracic leg and an extra, partially external, wing-bud (?) on the right side (pl. XX, figs. 1–2).

The meta-thoracic leg on the right side is double throughout its whole length, the basal joints of both legs being joined together as shown in the drawing, but the remaining joints are free. The two legs are arranged as mirror images of each other, although differing slightly *inter se* in the relative lengths of joints and number of setae. The extra leg, the anterior one of the pair, is without several of the setae that are present on a normal leg. This larva has also a peculiar swelling on the right side of the same somite, of the shape and in the position shown in the drawing, which probably indicates the presence of the rudiments of one or more extra wings forced into a partially external position by the internal pressure of other organs. It is to be regretted that I did not arrange to have this larva dissected, but as it is, I believe, the first recorded case of limb-duplication in a Lepidopterous larva, I was mainly concerned at the time with preserving and recording this feature. It will be noted that this is not a case of simple duplicity as defined by Dr. Cockayne in 1927 in connection with extra wings, but corresponds with his Group II in that the extra leg is in a mirror image position with regard to the normal one. So far as I can see, however, there is no trace of a second extra leg in secondary symmetry with the first as is

required by Bateson's Law, and in this respect the larva seems to agree with the " Crippled " mutants of *Drosophila melanogaster* recorded by Taku Komai and referred to by Dr. Cockayne. As already mentioned the extra leg has a less number of setae than normal.

2. A larva with spiral segmentation (pl. XX, fig. 4).

The 4th, 5th and 6th abdominal somites form a left-hand spiral. The pattern is slightly abnormal and asymmetrical on the spiral somites and the anterior trapezoidal seta is missing from the left half tergite of the 5th abdominal somite, while a reference to the figure will show that other setae are in abnormal positions. The right half tergite of the 4th abdominal somite does not appear to be entirely separated from the left half, although the pattern conceals this, but the left half tergite of the 5th is clearly not wholly separated from that of the 6th. The ventral surface looks nearly normal except that the prolegs (which, as also the spiracles, are all present) are not quite in line on each side owing to the 4th abdominal and all anterior somites being twisted over to the right by the distortion produced by the spiral. This larva appears almost identical in structure with Champion's *Hipocrita jacobaeae* described and figured by Dr. Cockayne, but as the right half of the 6th abdominal is enlarged toward the medio-dorsal line to accommodate the left half tergites of both the 5th and 6th I have included (perhaps wrongly) this somite also amongst those forming the spiral. It will be noted that I have described this larva as having a " left-handed " spiral. This agrees, I believe, with the generally accepted conception of the term (*e.g.* in Conchology, *Helix hortensis* m *sinistrorsum*), but reverses the terminology used by Dr. Cockayne in describing the *H. jacobaeae*, etc. This is unfortunate and, without some explanation, might lead to confusion, but I understand that Dr. Cockayne agrees with the term now used and that in his descriptions of spirals the terms " right " and " left "-handed became accidentally transposed.

3. A larva with the tergite of the 5th abdominal somite missing on the right side, etc. (pl. XXI, figs. 1–2).

As will be seen from the drawings, this larva is very peculiar. The full number of prolegs is present on both sides, but on the right side there is, from the dorsal aspect, but one tergite for the 5th and 6th abdominal somites as opposed to the two tergites on the left side. The setae on the right side of the 4th, 5th and 6th abdominal somites are also abnormal. The usual arrangement of setae is that shown for the 3rd abdominal somite, but on the 4th the post-spiracular seta on the right side is double while on the same side of the 5th and 6th the arrangement appears at first sight quite abnormal. It will be seen also that there is one spiracle only for these two somites on the right side. This larva puzzled me for some time, and I am indebted to Dr. Cockayne for a suggestion that has led me to work out the following possible explanation. If one assumes that the missing spiracle is that of the 5th abdominal somite and that the sternite of that somite is much shortened in its upper part on the right side and the right half of the tergite reduced to a small triangular piece fused with that of the 6th, then the setae can I think be homologised fairly well. On these assumptions the small seta in front of the spiracle becomes the supraspiracular seta of the 5th, the double seta is the postspiracular of the 5th identical with the similar seta on the 4th, while the seta near the anterior border of the somite would be the subspiracular. The lateral (or flange) seta of this somite on this side is placed very low and much nearer the proleg than usual. It is situated in a dark, clouded, area which gives the impression that there has been some vertical compression here. On the left side, and from beneath, both the 5th

and 6th abdominal somites appear nearly normal. The left half tergite of the 5th abdominal somite is shortened toward the medio-dorsal line, its posterior trapezoidal seta is placed lower down the side than usual and the pattern here is asymmetrical, while the larva has at this point a distinct bend as shown in the drawings. Owing to the complete absence of the upper part of the tergite of the 5th on this side, the anterior and posterior trapezoidals belonging to it are of course missing also. The spiracle and the other setae, *i.e.* those belonging strictly to the 6th, are nearly in their normal positions for that somite except that the sternite with its setae has been forced backward and somewhat downward relative to the spiracle by the pressure of the sternite, etc., of the 5th. There is, almost directly beneath the spiracle and just behind the double seta, a kind of scar or fold which evidently indicates the junction between the sternites of the 5th and 6th abdominal somites and bears out the interpretation suggested above.

4. A larva with the left half of the 4th abdominal somite absent (pl. XXII, figs. 1–3).

A reference to the drawings will give a better idea of the abnormalities of this larva than a detailed description. The pattern is asymmetrical on the 3rd and 4th abdominal somites, the posterior trapezoidal seta on the right side of the 3rd and the subspiracular seta on the same side of the 4th are missing. The proleg of the right side of the 4th is placed much farther back than usual, it is rather longer and thinner than normal and it is slightly twisted round so that the inner surface faces somewhat forward. The left half of the somite with its proleg is absent, causing a distinct angle in the larva at this point, while the anterior part of the larva is turned over slightly towards the right.

5. Another larva with the left half of the 4th abdominal somite missing (pl. XXI, fig. 4).

This larva is similar to that last mentioned and differs from it in detail only. There are no absent setae on the right side, and the tergite of the right half of the 4th abdominal somite is of a somewhat different shape from that in the last-mentioned larva. Other details and differences can best be appreciated from a reference to the drawings.

6. Another larva similar to the last (pl. XX, fig. 5).

This larva died while quite small. The main difference between it and that last described is that in this case it is the left half tergite of the 5th abdominal somite which is enlarged towards the medio-dorsal line instead of that of the 3rd. Here again a reference to the drawings will show the details better than a description.

7. A larva with the left half of the 5th abdominal somite much reduced, and other abnormalities (pl. XXI, figs. 5–6).

This larva also died while still small. The pattern on the 5th abdominal somite is asymmetrical and abnormal (see drawings). The left half of the 4th abdominal somite is slightly abnormal in shape, and its posterior lateral edge slightly overhangs the 5th. The right half of the 5th is shortened both dorsally and ventrally toward the middle line. The left half of the 5th is short and narrow and bears but one seta and no spiracle. The relative proleg on the left is very small and short but fairly well formed.

8. A larva with the right half sternite of the 4th abdominal much shortened and the relative proleg absent (pl. XXII, figs. 7–8).

The pattern is slightly asymmetrical, particularly on the right half of the 4th abdominal somite (see drawings). The right half tergite of this somite is shortened and crumpled so as to form a lump or projection toward its lateral border where it adjoins the sternite. The spiracle is present but placed con-

siderably higher than normal and all the setae are present though in abnormal positions (see drawings). The right half sternite of this somite is reduced to a short strip and bears no proleg. The larva has a pronounced hump on the dorsum at this somite. From the ventral aspect the appearance is very similar to that shown in pl. XXII, fig. 2, but with the sides reversed.

9. A larva with the tergite of the 1st abdominal somite shortened toward the medio-dorsal line, etc. (pl. XX, fig. 3).

The pattern is slightly asymmetrical on the 1st and 2nd abdominal somites (see drawings). There is no anterior trapezoidal seta on the right side of the 1st abdominal somite, no postspiracular seta on the same side of the 2nd (where the supraspiracular seta is placed farther back and a little lower than usual), and no postspiracular seta on the left side of the 3rd. Both halves of the tergite of the 1st abdominal somite are much shortened toward the medio-dorsal line, and the posterior trapezoidal setae are misplaced outwards. The right half tergite of this somite is not quite separated from that of the 2nd, and the tergites of the meta-thoracic and 2nd abdominal somites are considerably lengthened toward the medio-dorsal line so that each has a projection backward and forward respectively to compensate for the shortness here of the 1st.

10. A similar larva (pl. XXII, fig. 4).

The abnormality in this larva is of the same type as that last described but all setae are present, the pattern is somewhat differently arranged and there is no junction between the tergites of the 1st and 2nd abdominal somites.

11. A larva with a similar abnormality of the 5th abdominal somite (pl. XX, fig. 6).

This larva is very like that last described, even in the character of the abnormality of pattern, except that the somites that are affected are different. A reference to the drawings will show the slight differences of pattern, etc., better than a detailed description.

12. A larva with an abnormal proleg on the right side of the 3rd abdominal somite, etc. (pl. XXI, fig. 3).

The pattern on the dorsum of the 3rd and 4th abdominal somites is asymmetrical (fig. 3*a*). The right proleg of the 3rd abdominal somite is longer and tapers towards the foot much more than in a normal proleg. The foot itself of this proleg is small, the row of crotchets fringing the outer edge of the clasper, which normally consists of from 15 to 17 separate hooks, is much more recurved than usual and the crotchets themselves are small and frequently malformed so that it is difficult to count them accurately, but so far as I can see there are only 13 hooks. Just outside the row of crotchets and extending beyond the foot, is a little, pale-coloured, fleshy-looking protuberance which appears to be some extra, abnormal growth, over and above the usual number of joints of the proleg, but whether or not it is a vestigial extra joint or foot, I am unable to say. It appears to have no special characters that help in homologising it. A reference to fig. 3*b* will show the difference in shape of the abnormal proleg (*d*) when compared with the normal one on the adjoining somite (*c*).

13. A larva with the spiracle on the right side of the 8th abdominal somite absent, setae missing, etc. (pl. XXII, figs. 5–6).

This larva has no spiracle on the right side of the 8th abdominal somite, but there is a darkish, scar-like, mark running forward from about the position the spiracle should occupy to the junction with the 7th abdominal somite and thence downwards for a short distance where it ends in a dark spot (see drawing). The pattern on the 7th, 8th and 9th abdominal somites is asymmetrical and defective. The right half of the 7th is extended backward at the side so as to

form a kind of projection into the area of the 8th, and is also considerably narrower posteriorly than the left side. The right half of the 8th is short and narrow as is also that of the 9th, and these two somites are indistinguishably fused together on the right, while each of them carries but a single seta on the dorsum and no lateral setae on this side. The 8th has no trapezoidal setae on the left side, and the 7th has no posterior trapezoidal or supraspiracular setae on the right.

Summary.

In view of the variety of abnormality exhibited by these larvae, it appears inconceivable that they can have been the result of inherited characters. It is true that those with reduced somites on one side and those with half somites can be regarded as progressive developments of the same abnormality, but it seems very doubtful whether these can be correlated with the case of spiral segmentation. In the former cases the two halves of the somites anterior and posterior to the abnormal somite belong strictly in their actual positions as evidenced by the prolegs. They therefore differ from the cases of split and half somites in worms discussed by Morgan, which result in the external openings of the *vas deferens* being *apparently* though not actually, as he shows, situated on different somites. These he regards as arising in the same way as spiral segmentation through an error in the conjunction of the mesodermal blocks of the two halves of successive somites. Again, the case of the double leg could scarcely be the result of an inheritance factor which in another larva produced, *e.g.* spiral segmentation. In addition there is the definite fact that the ova were interfered with and in some cases injured, just at the time when colour changes, etc., in some ova showed that considerable development of the embryo had taken place in them, other ova being later, and it seems much more probable that this was the actual cause of the abnormalities. There was undoubtedly a wide range of variation in the stage of development when the ova were moved, so some were certain to be affected at the "critical" stage. The observed cases of abnormality amount to about 10 per cent. of the surviving larvae, but it is very probable that had the newly hatched larvae been examined, an even higher percentage would have been found, since it is likely that there were cases where the abnormality was such as to prevent the larva feeding or living for more than a very short time. Unfortunately many of the normal larvae failed to pupate, and I bred but one imago so could not carry on the brood to test whether the abnormalities would be inherited in the offspring.

In a recent paper dealing with the occurrence of spiral segmentation in six larvae of one of three broods (each of 100 to 150 larvae) of *Apantesis nais*, Dr. E. T. Learned discusses and reviews very carefully the information at present available as to the causes and origin of abnormal segmentation in insects and suggests, *inter alia*, and as a mere speculation, that there may be some inherited "instability of the developmental processes" apart from an actual germinal defect, "which renders certain individuals more liable to developmental accidents, from whatever cause," and goes on to say: "The occurrence of the six abnormal *nais* larvae in one brood while sister broods were normal similarly suggests a genetic basis for the aberration."

The fact that the aberration in the *nais* larvae was of one type only certainly appears very significant, but it is stated that the spiral segmentation affected either the 4th and 5th, or the 5th and 6th abdominal somites, and moreover was right-handed in some and left-handed in others, so that even here there was considerable variation. Unfortunately the attempts made to carry on the

strain failed for one reason or another so that absolute proof is lacking, and in view of my experience with *macilenta* it is just possible there was some shock, perhaps unnoticed, to some of the ova of one brood that did not affect those of the other broods.

In the case of the *macilenta* larvae, however, the aberrations being of so many different types may well indicate that they fall into a different category, and if the suggested cause of their abnormalities is correct, it would hardly seem necessary to assume any *special* inherited " instability of developmental processes " to account for them. When one considers how rare it must be for such injuries to occur to ova just at the " critical period " and without having fatal results, it would in fact seem unlikely (though not of course impossible) that the *macilenta* ova should, in addition to surviving such injuries, have belonged to a brood (from a chance wild female) which carried a factor or factors for a special inherited " instability of developmental processes." Rather I suspect the " instability " is common to all Lepidopterous ova, and indeed to the ova, using the word in its widest sense, of other Orders as well.

Undoubtedly abnormal segmentation is not so rare in Lepidopterous larvae as has appeared from the paucity of recorded cases, for I have recently been informed of, or have seen, several further examples of spiral and other segmental anomalies amongst bred Noctuid larvae which have not yet been described, and doubtless many more have been overlooked or ignored even amongst the comparatively few larvae reared in captivity.

Nevertheless it seems almost certain that such abnormalities may arise in different ways and from different causes, and, further, it must be remembered that bred insects are often subjected to very unnatural conditions, particularly when the ova are laid in captivity. Whatever may ultimately be discovered as to the origin, cause, and inheritance of such abnormalities, there is no doubt at present that Dr. Learned is right in his final remark that " No definite conclusions in regard " to them " will be warranted until much more has been learned about these interesting aberrations."

List of References.

Cockayne, E. A., 1929, Trans. Ent. Soc. Lond., **77** : 177.
——, 1927, *Ibid.*, **75** : 163.
Learned, E. T., 1932, J.N.Y. Ent. Soc., **40** : 167–182.
Morgan, T. H., 1892, J. Morph., Philad., **7** : 245–251.

Explanation of Plates XX–XXII.

Plate XX.

Fig. 1. Larva of *Amathes (Orthosia) macilenta*, Hb. Right lateral aspect of meso- and meta-thorax showing double leg on metathorax and external wing-bud (?).
2. Same larva. Dorsal aspect of metathorax.
3. Another larva of same species. Dorsal aspect of metathorax and 1st and 2nd abdominal somites, showing abnormal tergites.
4. Ditto. Dorsal aspect of 3rd, 4th, 5th and 6th abdominal somites showing spiral segmentation of 4th to 6th.
5. Ditto. Dorsal aspect of 3rd, 4th and 5th abdominal somites showing absence of left half of 4th.
6. Ditto. Dorsal aspect of 3rd, 4th, 5th and 6th abdominal somites showing abnormal tergites, etc.

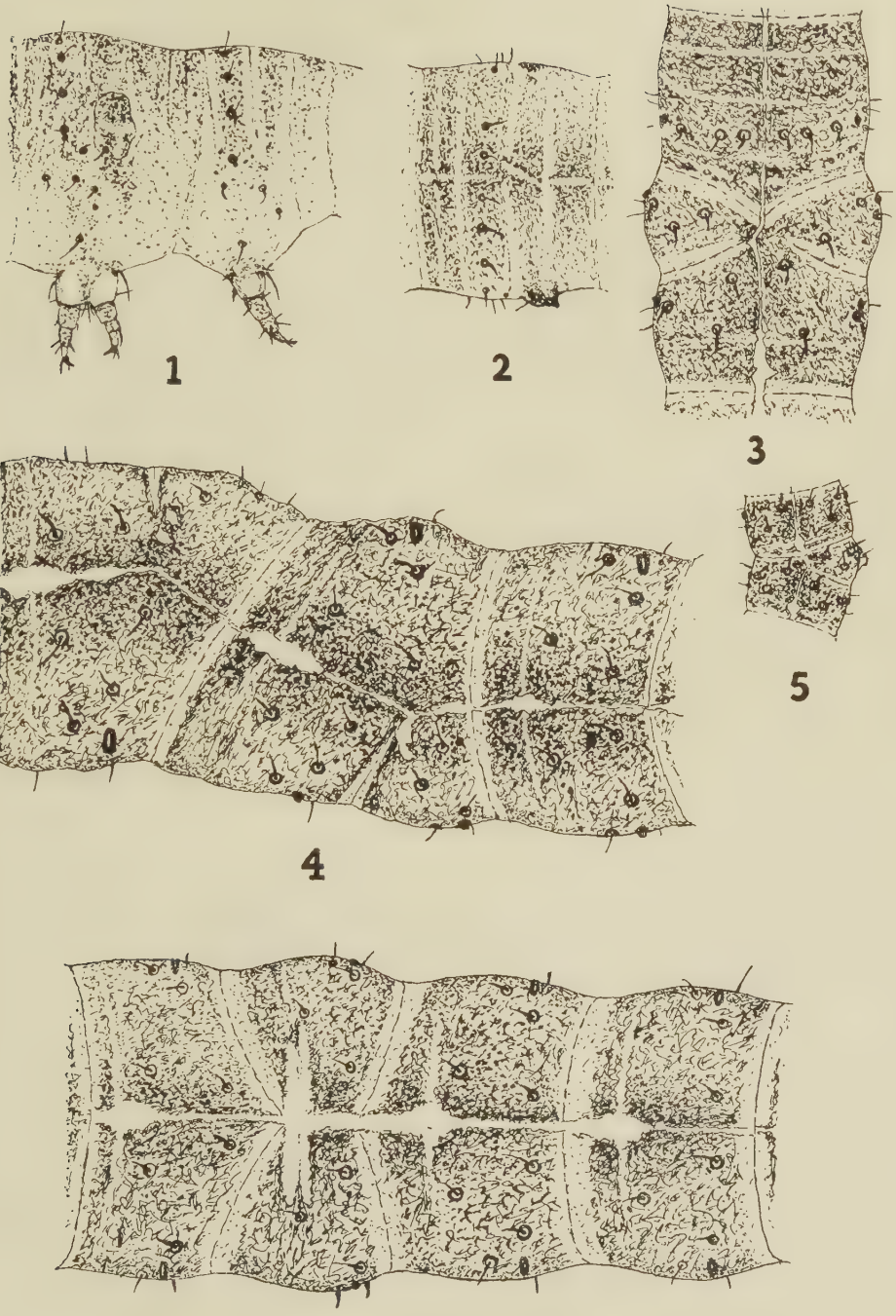
Plate XXI.

Fig. 1. Larva of same species. Dorsal aspect of 4th, 5th and 6th abdominal somites showing abnormal tergites.
2. Same larva. Right lateral aspect of 3rd, 4th, 5th, 6th and part 7th abdominal somites showing abnormal setal arrangement, etc.
3. Another larva of same species. (*a*) Part of dorsum of 3rd and 4th abdominal somites showing abnormal pattern. (*b*) Prolegs of same somites. (*c*) Normal foot of proleg of 4th abdominal somite. (*d*) Abnormal foot of proleg of 5th.
4. Ditto. Dorsal aspect of 3rd, 4th and 5th abdominal somites showing absence of left half of 4th.
5. Ditto. Dorsal aspect of 4th, 5th and 6th abdominal somites showing reduced left half of 5th, etc.
6. Same larva. Left lateral aspect showing reduced proleg, etc.

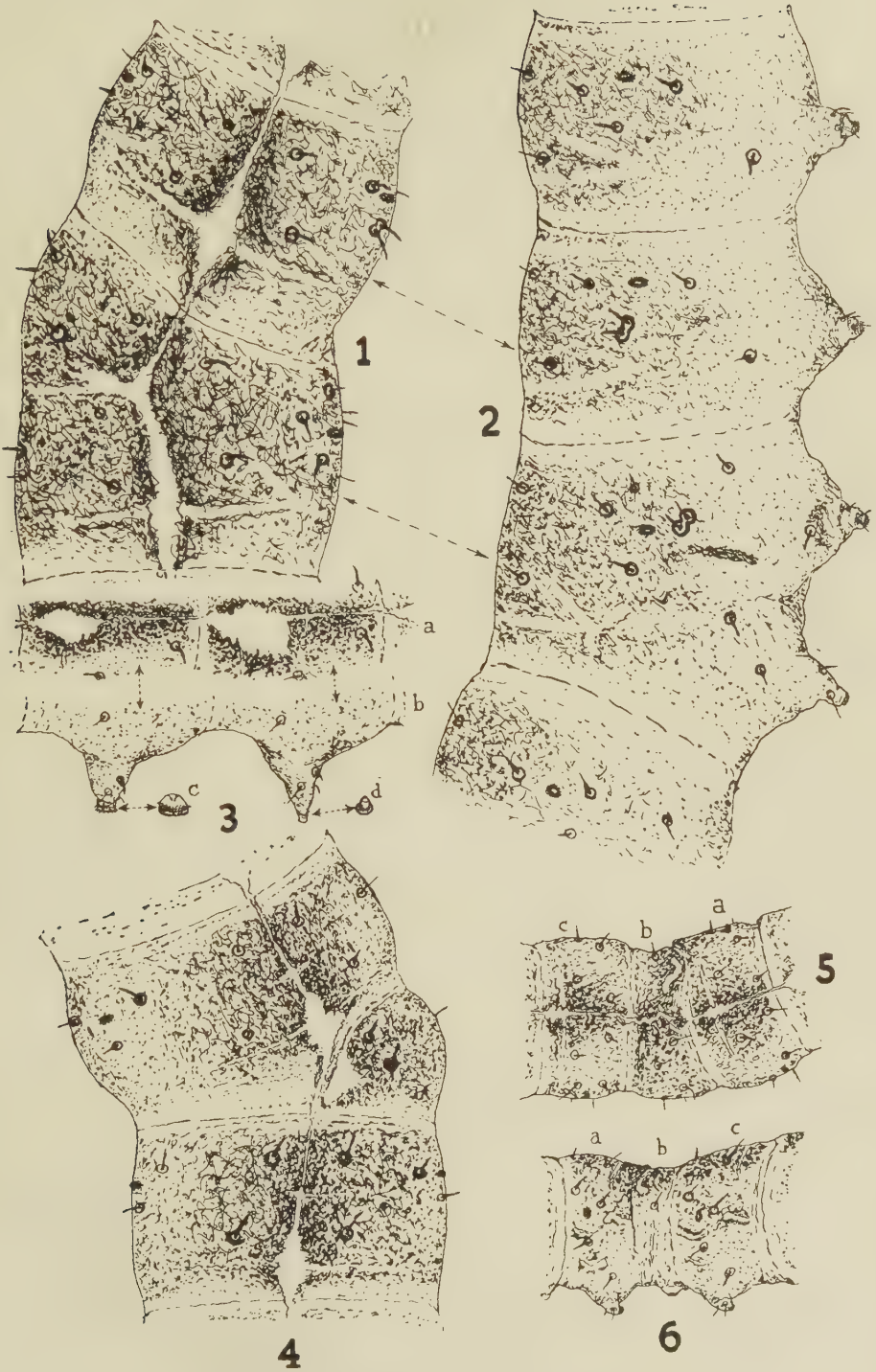
(Note. In the last two figures, the 4th abdominal somite is marked (*a*), the 5th (*b*) and the 6th (*c*).)

Plate XXII.

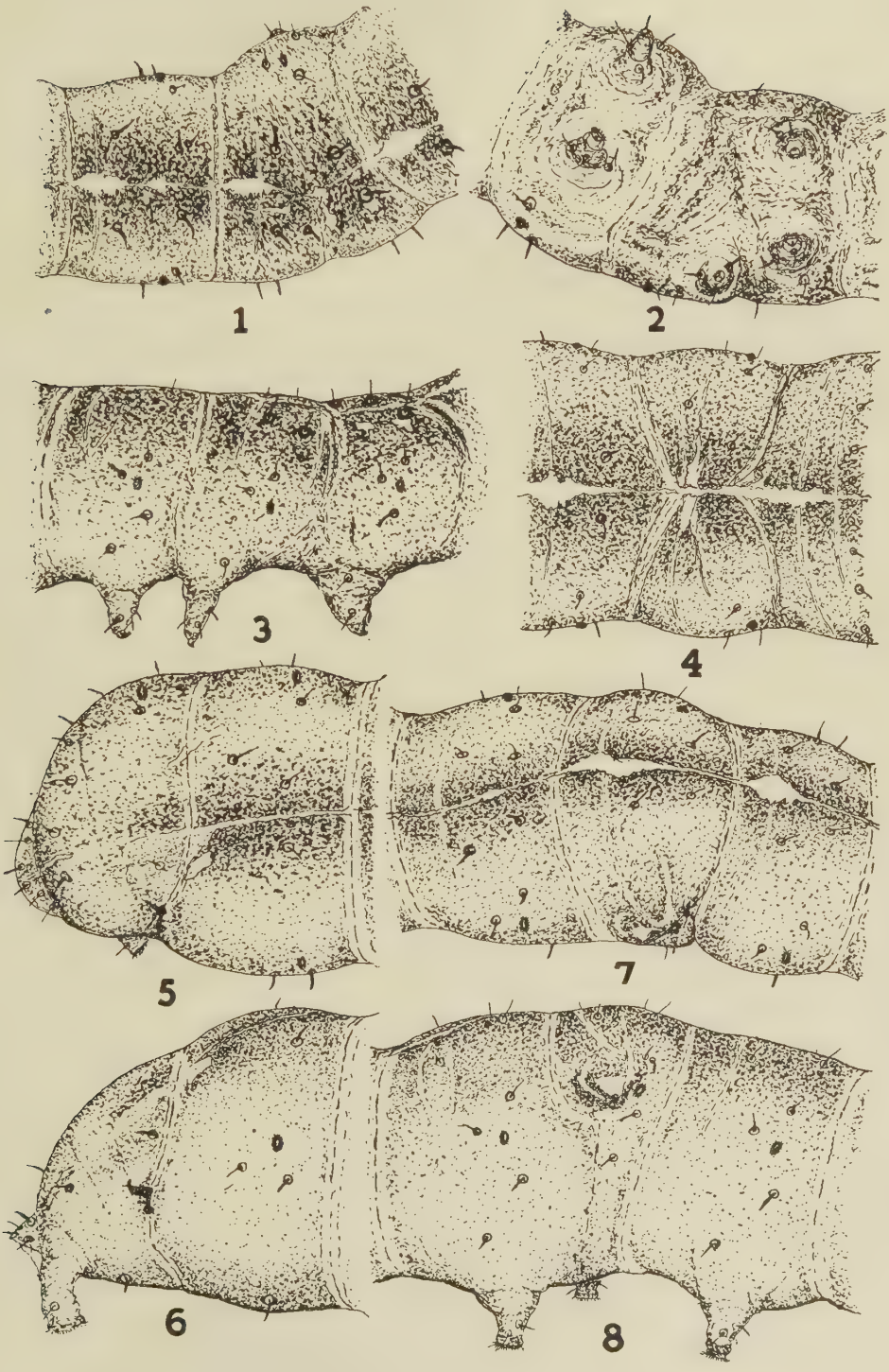
Fig. 1. Larva of same species. Dorsal aspect of 3rd, 4th and 5th and part of 2nd abdominal somites showing absence of left half of 4th.
2. Same larva. Ventral aspect of 3rd, 4th and 5th abdominal somites showing arrangement of prolegs.
3. Same larva. Right lateral aspect of same somites.
4. Another larva of same species. Dorsal aspect of 1st abdominal with parts of metathoracic and 2nd abdominal somites showing abnormal tergites.
5. Ditto. Dorsal aspect of 7th and posterior somites showing absence of spiracle on 8th, abnormal tergites, etc.
6. Same larva. Right lateral aspect of same somites.
7. Another larva of same species. Dorsal aspect of 3rd, 4th and 5th abdominal somites showing reduced right half tergite of 4th, etc.
8. Same larva. Right lateral aspect showing reduced sternite, etc., of 4th abdominal somite and absence of relative proleg on right. The left proleg of this somite just showing.



Abnormal larvæ of *Amathes macilenta*, **Hb.**



Abnormal larvæ of *Amathes macilenta*, Hb.



Abnormal larvæ of *Amathes macilenta*, **Hb.**

GENERAL INDEX

A

Acacia, relation of *Glossina* to, in Tanganyika, **206.**
Acnemia nitidicollis, **75.**
Acraea spp., attacked by birds, **25, 26.**
Aeolothrips fasciatus, **193.**
affinis, Didymus (see *D. aloysii-sabaudiae*).
Africa, birds attacking butterflies in, **21–26**; records of insect migration in, **103–110, 115**; Simuliids from, **37–51.**
africanus, Didymus.
aganice, Planema.
Aleurodes brassicae, anatomy of, **119–130.**
Aleurodes fragariae, **117.**
Aleurodes lonicerae, anatomy of, **126.**
Aleurodes proletella, **117.**
Aleurodes rubi, **117.**
Aleurodids, anatomy of British spp. of, **117–132.**
aloysii-sabaudiae, Didymus.
Amathes (*Orthosia*) *macilenta*, abnormal larvae of, **223–230.**
Amauris damocles psyttalea, attacked by bird, **23.**
ambiguus, Blepharipus.
America, Southern, migrations of butterflies in, **112–113.**
Amorpha populi, abnormal larvae of, **27–31.**
Andronymus neander, migration of, in Africa, **105–106.**
antiopa, Vanessa.
Apantesis nais, **228.**
Aphis laburni, prey of *Polemistus* (*Passaloecus*) *barabbas* in Malaya, **97.**
Appias libythea, migration of, in Ceylon, **111.**
Aptinothrips rufus, internal anatomy of, **185–204.**
Arachnocampa luminosa, **87.**
Arctic, record of butterfly from, **114.**
atalanta, Vanessa (*Pyrameis*).
Atella phalantha, migration of, in Tanganyika, **105.**
Athysanus sejugendus, **100.**
atratus, Taeniothrips.
Australia, migration of butterflies in, **111.**

B

bachmanni, Libythea.
barabbas, Passaloecus (*Polemistus*).
barbatus, Pentalobus.
Belenois java, migration of, in Australia, **112.**
Belenois mesentina, migration of, in Africa, **106, 108.**
Belenois severina, migration of, in Africa, **106, 107.**
Belgian Congo, Passalids of, **53–65.**
Belyta, parasite of *Platyura*, **86.**
Berlinia, relation of *Glossina* to, in Tanganyika, **206.**
bicolor, Mimesa.
bipunctatus, Nephotettix.
Birds, attacks of, on butterflies, **21–26.**
Blepharipus ambiguus, **100.**
Bolitophila luminosa, **87.**
boopis, Junonia.
Brachystegia, relation of *Glossina* to, in Tanganyika, **206.**
Braconids, catalogue of British, **67–74.**
brassicae, Aleurodes.
British Isles, catalogue of Braconids of, **67–74**; migrations of insects in, **112, 114**; anatomy of Aleurodids in, **117–132**; list of Hymenopterous parasites of Lepidoptera in, **133–183**; abnormal larvae of *Amathes macilenta* in, **223–230.**
brunnea, Phloeothrips.
buttneri, Didymus (see *D. nachtigalli*).

C

Calluna vulgaris, food-plant of *Amathes macilenta*, **223.**
Carabids, types of Oriental, described by Motchulsky, **1–19**; index to genera and species, **18.**
cardui, Pyrameis (*Vanessa*).
carnifex, Didymus (see *D. punctipennis*).
casei, Piophila.
Catopsilia, migration of, in Malaya, **111.**
Catopsilia florella, attacked by bird, **23**; migrations of, in Africa, **106, 108, 110.**
Catopsilia statira, migration of, in Dutch Guiana, **112**
cayor, Passalus.
Cephalothrips yuccae, **190.**
cerealium, Limothrips.
Ceroplatus, oxalic acid in web fluid of larvae of, **90–92.**
Ceroplatus lineatus, biology of, **83.**
Ceroplatus testaceus, **85.**
Ceylon, migration of butterflies in, **111.**
chrysippus, Danais.
communis, Didymus (see *D. nachtigalli*).
congoensis, Didymus.
coprophila, Sciara.
Crataegus oxyacantha, food-plant of *Amathes macilenta*, **224.**
Crotalaria saltiana, **97.**
Cupido gaika, attacked by bird, **26.**
Cupido hippocrates, attacked by bird, **26.**
curvilineatus, Didymus.

D

damnosum, Simulium.
damocles, Amauris.
Danais chrysippus, **109**; attacked by bird, **23.**
Danais chrysippus petilia, migration of, in Australia, **111.**
Danais plexippus, migration of, in U.S. America, **113.**
Dicolus hirticornis, parasite of *Macrocera stigma*, **87.**
Dicolus insectator, parasite of *Platyura*, **87.**
Didimoides (see *Didymus*).
Didymus, revision of, from Belgian Congo, **58–65**; key, **58–60.**
Didymus ealensis, **sp.n.**, from Belgian Congo, **63.**
discoloria, Platyura.
distinguendus, Haplothrips.
dorsalis, Polemistus.
dracaenae, Heliothrips.
Drosophila melanogaster, **29, 225.**
duplicatus, Didymus (see *D. congoensis*).

E

ealensis, Didymus.
egina, Acraea.
Epeus (see *Pentalobus*).
ephippiger, Hemianax.
ericae, Taeniothrips.
Erionomus spp., from Belgian Congo, **54, 55.**
Eriosternus (see *Erionomus*).
ethosea, Mesoxantha.
Eumelosomus (see *Didymus*).
eurytus, Pseudacraea.

F

fasciata, Platyura (*Macrocera*).
fasciatus, Aeolothrips.
flavescens, Pantala.
florella, Catopsilia.
fragariae, Aleurodes.
Fridericia striata, effect of oxalic acid on, **91, 92.**
fulgens, Urania.
furcifera, Sogata.
fuscus, Melanthrips.

G

gaika, Cupido.
Game, relation of *Glossina* to, in Tanganyika, **209, 217.**
Glossina morsitans, bionomics of, in Tanganyika, **205–221.**
Guiana, Dutch, migration of *Catopsilia statira*, in **112.**

H

haemorrhoidalis, Heliothrips.
Haplothrips distinguendus, internal anatomy of, **185–204.**
hecabe, Terias.
Helictes mediator, parasite of *Platyura*, **87.**
Heliothrips dracaenae, **189.**
Heliothrips haemorrhoidalis, internal anatomy of, **185–204.**
Hemianax ephippiger, migration of, in Red Sea, **115.**
Hipocrita jacobaeae, **225.**
hippocrates, Cupido.
hirticornis, Dicolus.
hospes, Pseudogonatopus.
hostilis, Passalus.
Hypolycaena philippus, attacked by bird, **26.**

I

insectator, Dicolus.
intricatus, Scolytus.
iole, Nathalis.

J

jacobaeae, Hipocrita.
java, Belenois.
Junonia boopis, migration of, in Africa, **109.**

K

Kakothrips robustus, internal anatomy of, **185–204.**
klugi, Didymus.

L

laburni, Aphis.
laevipectus, Didymus.
laevisternus, Didymus.
laius, Libythea.
latericrinitus, Erionomus.
laticornis, Platyura.
Lepidoptera, tarsal sense-organs in, **33–36**; Hymenopterous parasites of British, **133–183**; abnormal larvae of, **223–228.**
leptogaster, Polylepta.
Libellula quadrimaculata, migration of, in Britain, **114.**
Libythea bachmanni, migration of, in U.S.A., **113.**
Libythea laius, **109.**
libythea, Appias.
ligustri, Sphinx.
Limothrips cerealium, internal anatomy of, **185–204.**
lineatus, Ceroplatus.
livingstoni, Didymus.
lonicerae, Aleurodes.
luminosa, Arachnocampa; Bolitophila.
lycoa, Acraea.

M

macarista, Planema.
macfarlanei, Neosciara.
macilenta, Amathes (*Orthosia*).
Macrocera, Hymenopterous parasites of, **86.**
Macrocera fasciata, **86.**
Macrocera stigma, biology of, **85.**

Macrocera vittata, **86.**
Malaya, new Sphecoids in, **93–101**; migration of butterflies in, **111.**
melanogaster, Drosophila.
Melanthrips fuscus, internal anatomy of, **185–204.**
mesentina, Belenois.
Mesoxantha ethosea, attacked by bird, **24.**
Migration, of insects, collected records relating to, **103–115.**
milonia, Precis.
Mimesa bicolor, predacious on Jassids, **100.**
montana, Planema aganice.
morsitans, Glossina.
Motchulsky, types of Carabids described by, **1–19.**
Mycetophilids, biology of, **75–92.**
Mylothris rüppelli, **108.**
Mylothris sagala, **109.**

N

nachtigalli, Didymus.
nais, Apantesis.
Nathalis iole, possible migration of, in U.S.A., **113.**
neander, Andronymus.
nemoralis, Platyura.
Neosciara macfarlanei, **88.**
Nephotettix bipunctatus, prey of *Psenulus sogatophagus* in Malaya, **100.**
nigricornis, Platyura.
nitidicollis, Acnemia.

O

obscura, Pseudacraea eurytus.
octavia, Precis.
Odontothrips ulicis, internal anatomy of, **185–204.**
oenone, Precis.
Onchocerca volvulus, transmitted by *Simulium damnosum*, **49.**
Oriental Region, types of Carabids from, described by Motchulsky, **1–19.**
orina, Acraea.
Orthosia macilenta (see *Amathes*).
Oxalic Acid, in larval webs of *Platyura* and *Ceroplatus*, **90–92.**

P

palini, Pentalobus.
pallida, Platyura.
Pantala flavescens, migration of, in Kenya, **115.**
parastictus, Didymus.
Passalids, of Belgian Congo, **53–65.**
Passaloecus (*Polemistus*) *barabbas*, **sp.n.**, from Malaya, **93–97.**
Passaloecus (*Polemistus*) *dorsalis*, predacious on *Attus* in Réunion, **97.**
Passalus cayor, probably referable to *Didymus*, **58.**
Passalus hostilis, possibly an African species, **58.**
Pentalobus, revision of, from Belgian Congo, **56–58.**
petilia, Danais chrysippus.
phalanta, Atella.
philippus, Hypolycaena.
Phloeothrips brunnea, **193.**
pilosus, Erionomus.
Piophila casei, prey of *Platyura*, **79.**
Planema aganice montana, attacked by bird, **24.**
Planema macarista, attacked by bird, **25.**
planiceps, Erionomus.
platypleura, Erionomus.
Platyura spp., biology of, **75–90**; Hymenopterous parasites of, **86**; oxalic acid in web of larvae of, **90–92.**
plexippus, Danais.
Polemistus (see *Passaloecus*).
Polylepta leptogaster, web of larva of, **88.**
populi, Amorpha.
Porcellio scaber, **84.**
Precis milonia rauana, attacked by bird, **24.**
Precis octavia sesamus, **108.**
Precis oenone, **109.**
proletella, Aleurodes.
Psenulus sogatophagus **sp.n.**, in Malaya, **97–101**; prey of, **100.**
Pseudacraea eurytus, birds attacking in Uganda, **21, 23, 24.**
Pseudogonatopus hospes, **100.**
punctipectus, Didymus.
Pyrameis atalanta (see *Vanessa*).
Pyrameis (*Vanessa*) *cardui*, records of migration of, **104.**

Q

quadrimaculata, Libellula.

R

rauana, Precis milonia.
robustus, Kakothrips.
rubi, Aleurodes.
rufus, Aptinothrips.
ruppelli, Mylothris.
ruwenzoricus, Didymus.

S

Sacciolepis myosuroides, Psenulus sogatophagus nesting in, in Malaya, **101.**
sagala, Mylothris.
sansibaricus, Didymus.
Sciara coprophila, **88.**
Scolytus intricatus, prey of *Platyura*, **79.**
sejugendus, Athysanus.
servona, Acraea.
sesamus, Precis octavia.
severina, Belenois.
simulator, Didymus.
Simulium damnosum, anatomy of, **37–46**; biology of, **47–51.**
Sogata furcifera, prey of *Psenulus sogatophagus* in Malaya, **100.**
sonchi, Trialeurodes.
Sphinx ligustri, abnormal larvae of, **27–31.**
statira, Catopsilia.
stigma, Macrocera.

T

tabaci, Thrips.
Taeniothrips ericae, **193.**
Taeniothrips vulgatissimus, internal anatomy of, **185–204.**
Tanganyika, bionomics of *Glossina morsitans* in, **205–221**; migration of butterflies in, **105.**
Tarsal sense-organs, in Lepidoptera, **33–36.**
Terias hecabe, migration of, in Ceylon, **111.**
terpsichore, Acraea.
terra, Pseudacraea eurytus.
Thrips tabaci, internal anatomy of, **185–204.**
Thysanoptera, internal anatomy of, **185–204.**
tirikensis, Pseudacraea eurytus.
Trialeurodes sonchi, anatomy of, **126, 127.**
Trialeurodes vaporariorum, **117.**
Trichoniscus pusillus, **84.**
Trigona, nest of, robbed by *Passaloecus barabbas* in Malaya, **97.**

U

Uganda, birds attacking butterflies in, **21–27.**
ulicis, Odontothrips.
United States of America, migration of butterflies in, **113.**
Urania fulgens, migration of, in S. America, **112, 113.**

V

Vanessa antiopa, **33.**
Vanessa atalanta, migration of, in Britain, **112**; tarsal sense-organs in, **33–36.**
Vanessa cardui (see *Pyrameis*).
vaporariorum, Trialeurodes.
vittata, Macrocera.
volvulus, Onchocerca.
vulgatissimus, Taeniothrips.

Y

yuccae, Cephalothrips.

Z

zetes, Acraea.

ERRATA.

p. 24, line 30, for "*rauaua*" read "*rauana.*"
p. 61, line 15, for "*aloysii sabaudiae*" read "*aloysii-sabaudiae.*"
p. 87, 3 lines from end, for "*latricornis*" read "*laticornis.*"
pl. II, explanation, transpose "fig. 4" and "fig. 6."

PRINTED IN GREAT BRITAIN BY RICHARD CLAY & SONS, LIMITED,
BUNGAY, SUFFOLK.